NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

EFFECTS OF PERSONNEL INJURIES ON CINC MISSION READINESS

by

Erin G. Snow

September, 1997

Thesis Advisor: Samuel H. Parry
Second Readers: Robert R. Read
Keith Prusaczyk

DUDLEY KNOX LIBRARY
NAVAL POSTGRADUATE SCHOOL
MONTEREY, CA 93943-5101

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	September, 1997	Master's Thesis

4. TITLE AND SUBTITLE
EFFECTS OF PERSONNEL INJURIES ON CINC MISSION READINESS

5. FUNDING NUMBERS

6. AUTHOR(S)
Snow, Erin G.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Postgraduate School
Monterey, CA 93943-5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(maximum 200 words)*

According to the Office of the Under Secretary of Defense for Acquisition and Technology, the Department of Defense currently does not have sufficient means of tracking and/or understanding the magnitude of problems associated with musculoskeletal (MS) injuries amongst its civilian and active duty personnel. The Naval Health Research Center (NHRC), San Diego, CA, has been conducting its own studies and research with regard to MS injuries incurred by Naval Special Warfare (NSW) personnel since October, 1993. One elite group within this community which was targeted for the research is the Navy SEALs. The purpose of this thesis is to determine the impact on operational readiness using the measure of effectiveness (MOE): mission dependent man-days lost over time as a result of MS injuries incurred by Navy SEALs. Because NHRC has been seeking a database sufficient to answer such questions related to operational readiness, suggestions for software system design are provided. Results for man-days lost over time are presented for two missions, two mission segments, and three separate activities.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Musculoskeletal Injuries, Navy SEALs, Naval Special Warfare, Operational Readiness	100
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFI- CATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

Approved for public release; distribution is unlimited

EFFECTS OF PERSONNEL INJURIES ON CINC MISSION READINESS

Erin G. Snow
Lieutenant, United States Naval Reserve
B.S., Southeastern Louisiana University, 1988

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN OPERATIONS RESEARCH

from the

NAVAL POSTGRADUATE SCHOOL
September, 1997

ABSTRACT

According to the Office of the Under Secretary of Defense for Acquisition and Technology, the Department of Defense currently does not have sufficient means of tracking and/or understanding the magnitude of problems associated with musculoskeletal (MS) injuries amongst its civilian and active duty personnel. The Naval Health Research Center (NHRC), San Diego, CA, has been conducting its own studies and research with regard to MS injuries incurred by Naval Special Warfare (NSW) personnel since October, 1993. One elite group within this community which was targeted for the research is the Navy SEALs. The purpose of this thesis is to determine the impact on operational readiness using the measure of effectiveness (MOE): mission dependent man-days lost over time as a result of MS injuries incurred by Navy SEALs. Because NHRC has been seeking a database sufficient to answer such questions related to operational readiness, suggestions for software system design are provided. Results for man-days lost over time are presented for two missions, two mission segments, and three separate activities.

TABLE OF CONTENTS

I. INTRODUCTION 1

A. MUSCULOSKELETAL INJURIES IN THE DEPARTMENT OF DEFENSE 1

B. NAVAL HEALTH RESEARCH CENTER 2

C. PURPOSE 2

II. BACKGROUND 5

A. DATA PROVIDED 5
1. Purpose 5
2. Files Generated by MADSYS 8

B. DATA EDITING/CORRECTION 10
1. Creation of a Single Treatment File 10
2. Editing the Treatment File 11
3. Lost Data 11
4. Retrieving MS Injury Data Incurred by Navy SEALs 12
5. Changing the Date Format 12

C. IMPACT ON OPERATIONAL READINESS 13

D. THESIS ORGANIZATION 14

III. METHODOLOGY 15

A. DATA COLLECTION ISSUES/ASSUMPTIONS 15

B. CREATION OF TREATMENT/LIMITED DUTY DATABASE 17
1. Treatment and Limited Duty Files 17
2. Database Design 19

C. MAPPING DIAGNOSIS CODES TO LIMITED DUTY (LD) CODES 22

D. CREATION OF TABLES FOR EACH LD CODE 24

E. SEAL MISSIONS AND MISSION SEGMENTS 25

F. COMPUTING THE MOE FOR EACH MISSION AND MISSION SEGMENT 28
1. Comparison of LD Codes for Each Mission and Mission Segment 28
2. Comparison of "T" and "D" Type Files 30
3. Computing the MOE 32
4. Subsequent Computations 33

IV. RESULTS 35

A. SAMPLE MISSIONS AND MISSION SEGMENTS 35
B. SAMPLE ACTIVITIES 39

C. OVERVIEW OF GRAPHICAL RESULTS 43
1. Similarities in Overall Shape 43
2. Differences in Overall Shape 44

V. RECOMMENDATIONS AND CONCLUSIONS 45

A. SUGGESTED DATABASE DESIGN 45
1. Data Items to be Collected 45
2. Use of a Central Database 47
B. RECOMMENDATIONS FOR FUTURE RESEARCH 47
1. Software Design 47
2. Determining Distribution of MS Injuries 48
C. CONCLUSIONS 48

APPENDIX A. SAMPLE OUTPUT OF TREATMENT FILE CREATED IN PARADOX 51

APPENDIX B. TRTDAYS AND LIMDUTY FILES CREATED IN S-PLUS 53

APPENDIX C. FILE REFLECTING MAPPING OF DIAGNOSIS CODES TO LD CODES 61

APPENDIX D. S-PLUS COMMANDS AND FUNCTIONS FOR COMPUTING MISSION ONE MOE 63

APPENDIX E. MISSION ONE FILE: MAN-DAYS LOST OVER TIME 69

APPENDIX F. ACTIVITY FOUR FILE: MAN-DAYS LOST OVER TIME 77

LIST OF REFERENCES 85

INITIAL DISTRIBUTION LIST 87

EXECUTIVE SUMMARY

According to the Office of the Under Secretary of Defense, the Department of Defense currently does not have sufficient means of tracking and/or understanding the magnitude of problems associated with musculoskeletal (MS) injuries amongst its civilian and active duty personnel. Active duty data sources are even more limited than those of civilian data sources. Although each branch of the armed forces regularly collects back injury data, there have been indications of under-reporting and problems with discrepancies.

The Naval Health Research Center (NHRC), San Diego, CA, has been conducting its own studies and research with regard to MS injuries incurred by Naval Special Warfare (NSW) personnel since October, 1993. Because Navy SEALs are an elite group within the NSW community and undergo what is considered the most extensive military and physically demanding training in the world, they were targeted for this research by NHRC. NHRC has been conducting studies and research of the occurrence of MS injuries incurred by NSW personnel, and it has been actively seeking a software system design that would generate data sufficient to answer questions related to operational readiness.

Dr. Keith Prusaczyk, Head of Human Performance Department, NHRC, has been aggressively involved in this undertaking. Data collected by a software system temporarily in use at Naval Special Warfare Group Two (NSWG-TWO) Medical, Little Creek, VA, was released to and provided by Dr. Prusaczyk for use in this thesis.

The purpose of this thesis is to determine the impact on operational readiness using the measure of effectiveness (MOE): man-days lost over time (for specified missions and mission segments) as a result of MS injuries incurred by Navy SEALs. Furthermore, because the data were lacking some of the information necessary to more accurately compute the MOE, suggestions for data items to be collected as well as for software system design are provided.

Because the software system which generated the data used in this thesis was designed using relational databases, the focal point of the experience tour at NHRC was to determine the "link" between output files generated and to extract the data from each of those files considered necessary in computing the MOE. This resulted in the creation of a new database utilized for computations.

The total number of Navy SEALs is approximately 2000, of which 900 are attached to NSWG-TWO. The database used for this thesis covered a 13 month period

for NSWG-TWO SEALs. During that period, 343 different SEALs received treatment for MS injuries. Before computing the MOE, only the information regarding Navy SEALs with MS injuries was extracted. Because some SEALs were given limited duty status (i.e., no duty, no upper body, no lower body, no jumping, etc.) and/or received treatment for their injuries, two separate files were used in the computations:

- One file called *limduty* composed of all SEALs given limited duty status for certain injuries.
- One file called *treatment* composed of all SEALs receiving treatment for certain injuries.

Sample missions and mission segments provided in NHRC Technical Report Number 95-24 titled "Physical Demands of U. S. Navy Sea-Air-Land (SEAL) Operations", were selected to compute the MOE. Each SEAL mission is composed of several mission segments, with each segment consisting of several activities. The MOE was computed after determining which particular diagnoses could potentially affect specific activities performed in each of the missions and mission segments.

In order to see the variation from mission(s) to mission segment(s), the MOE was adjusted to be activity dependent man-days lost over time as a result of MS injuries incurred by Navy SEALs. Three sample activities regularly performed by SEALs were selected. Results for man-days lost over time are presented for two missions, two mission segments, and the three separate activities.

The methodology implemented in this thesis is easily adapted to any particular population at risk and the suggested software system design can be easily adjusted for use by any branch of the armed forces.

ACKNOWLEDGEMENTS

The author would like to thank Dr. Sam Buttrey for his assistance in writing functions in S-Plus necessary to perform required computations and Dr. Lyn Whitaker for the use of a computer necessary to support the large database used in the thesis. The author would also like to thank Brandi Schober, Naval Special Warfare Group Two Medical, for her assistance in collecting and editing the data used in this thesis and for her guidance in determining types of activities which are limited by particular sports- and exercise-related injuries incurred by Naval personnel.

Special thanks to my thesis advisor, Dr. Sam Parry, and second readers, Dr. Robert Read and Dr. Keith Prusaczyk, for their continued guidance, insight, and support.

Of course, many thanks to Dr. Keith Prusaczyk and Dr. Hal Goforth, Naval Health Research Center, San Diego, CA, for the opportunity to pursue such an important area of research.

I would also like to extend special thanks to my sister, Catherine Guidroz, who devoted a year of her time to assist my husband and me in caring for our son during a great time of need and to my parents, Melvin and Rosanna Guidroz, for allowing my sister to spend this time with our family. Without their love and support, the road would have been much harder to travel.

Thanks most of all to my husband, Todd Snow, for his continued love and support in providing me the extra time necessary to complete this work, and also to our son Ian who made the journey a very worthwhile experience.

I. INTRODUCTION

A. MUSCULOSKELETAL INJURIES IN THE DEPARTMENT OF DEFENSE

According to the Office of the Under Secretary of Defense for Acquistion and Technology, [Ref. 1], musculoskeletal (MS) injuries are a serious topic of concern for the Department of Defense (DoD).

> Work-related musculoskeletal disorders (WRMDs) include upper extremity, neck, back, and leg conditions. Conditions directly related to workspace environment, jobs, and tools account for a significant portion of the injuries and illnesses reported to the Department of Labor (DoL). Sprains and strains account for approximately 44 percent of the injuries and illnesses resulting in lost work time U. S. wide (Bureau of Labor Statisitics, 1992). Forty percent of these sprains and strains involved the back and other portions of the trunk.
>
> Data sources in the DoD are limited. Most databases do no collect the data needed to accurately describe the magnitude of WRMSDs. Although back injury data is routinely collected by all branches of the armed forces, there are indications of under-reporting and disturbing discrepancies.... Data provided by the Army Safety Center (ASC) and the DoL Office of Workers Compensation (OWSP) are among those data sources reflecting such discrepancies and under-reporting.
>
> Active duty data are even more limited. One of the most reliable data sources available, however, is information obtained as a result of retirement of personnel for medical reasons. The top five medical retirement diagnoses involve musculoskeletal conditions and account for the majority of the retirements. [Ref. 1]

The DoD Ergonomics Working Group was in the process of developing a template for cross-sectional epidemiologic study to be used by each branch of the armed forces in order to describe the magnitude of WRMSD problems in the DoD. According to the information obtained from this web site, the process started in 1995. One of the advantages of the design of this study was that comparable data would be collected across all branches of the armed forces. Furthermore, if the study would determine that "more accurate data are a concern for the DoD, funding should be allocated to perform the study on a larger scale". [Ref. 1]

To date, however, there has been no software system developed to generate the type of information necessary to reflect the magnitude of the problem of MS injuries incurred by personnel under the cognizance of the DoD.

B. NAVAL HEALTH RESEARCH CENTER

Since October, 1993, the Naval Health Research Center, Naval Submarine Base, San Diego, CA, has been conducting its own research and studies of exercise- and sports-related injuries among particular populations at risk considered to be a concern for the United States Navy. Of particular interest was the occurrence of musculoskeletal injuries incurred by an elite population within the Naval Special Warfare (NSW) community - the Navy SEALs (Sea, Air, and Land). Because Navy SEALs are considered to undergo the most extensive and physically demanding military training in the world, MS injuries are predominant among them. Because SEALs are an elite group within the Navy and DoD and require such a selective screening process (both in terms of physical and mental qualifications and performance capabilities), this particular population at risk warrants even more special attention.

Dr. Keith Prusaczyk, Head of Human Performance Division, NHRC, has been actively involved in the process of establishing a system of data collection which could be utilized by all branches of the armed forces in tracking musculoskeletal injuries incurred by Naval personnel. The work completed in this thesis is a result of continued research in this area which began during an experience tour at NHRC under the direction of Dr. Prusaczyk.

C. PURPOSE

Each SEAL mission is composed of several mission segments, with each segment consisting of several activities. The purpose of this thesis is two-fold:

- To determine the impact on operational readiness of man-days lost over time (for specified missions, mission segments or activities) as a result of musculoskeletal injuries incurred by Navy SEALs.
- To establish which types of data items should be collected in order to more accurately determine man-days lost.

The data used to accomplish this task were collected by a software system, Medical Analytic Data System (MADSYS), which was temporarily in use by Naval Special Warfare Group Two (NSWG-TWO) Medical, Naval Amphibious Base, Little Creek, VA. To accomplish the goals described above, this thesis provides researchers at NHRC with insight and suggestions for the design of a software system more conducive to answering such questions of concern. It will also provide a better mechanism for the tracking and

understanding of the magnitude of problems associated with MS injuries among Naval personnel.

The methodology implemented for determining the impact on operational readiness by this particular population at risk may be easily adapted to any such population at risk. Suggestions for the software system design and data items to be collected are also easily adjusted for use by any branch of the armed forces within the Department of Defense.

II. BACKGROUND

In October, 1993, researchers employed within Special Operations Division (SOD), Naval Health Research Center (NHRC), San Diego, CA, submitted a proposal titled "Exercise-related Injuries of Special Operations Personnel" to the Naval Medical Research and Development Center (NMRDC), Bethesda, MD.

The purpose of this particular work unit was to decrease the incidence and morbidity of musculoskeletal (MS) injuries sustained by Naval Special Warfare (NSW) trainees and operators. Study A of the proposal outlined the further development and maintenance of a computerized, epidemiologic database to provide researchers, Special Warfare personnel, and medical providers with descriptive epidemiologic data regarding MS injuries among Special Warfare trainees and operators. The data were to be used to : 1) determine frequency and distribution of MS injury; 2) determine morbidity due to MS injury (i.e. recovery time, acute and long-term sequelae, attrition, cost, operational impact); 3) aid in health-care planning; 4) guide and support future research efforts regarding risk factors, etiology, diagnosis, treatment, and prevention of MS injury; 5) evaluate the efficacy of specific interventions; and 6) serve as the information source for the NSW community. [Ref. 2: p. 4]

Data being collected currently by some of the medical facilities affiliated with the NSW community are generated by a software system known as SMART (Sports Medicine And Research Team). However, a temporary source of data collection provided by a software system, Medical Analytic Data System (MADSYS), was in use at NSWG-TWO Medical, Naval Amphibious Base (NAB), Little Creek, VA, from December, 1995 through February, 1997. These data were released to Dr. Keith Prusaczyk, NHRC, and provided for use in this thesis.

A. DATA PROVIDED

1. Purpose

Dr. Prusacyzk was particularly interested in using the data provided by MADSYS for two reasons: 1) to determine the adequacy of the data provided in answering some extremely important questions such as how MS injuries among Navy SEALs impacts operational readiness in terms of down-time; and 2) to show the importance of such data collection by attempting to answer that question with the given database.

As an exercise physiologist, Dr. Prusacyzk regularly participates in and conducts studies regarding sports- and exercise-related injuries, primarily amongst SEALs and men enrolled at Basic Underwater Demolition/SEALs (BUD/S). He has continued to provide valuable information to the people in charge of the training program at BUD/S. Although the data provided by MADSYS were collected at NSWG-TWO, the primary command of East coast SEAL teams and units in an operational setting, the procedures implemented and information provided by the analysis of these data will lend themselves to the training arena as well. The occurrence of MS injuries is predominantly high at BUD/S. As a result, there exists a great need to reduce the frequency of occurrence not only at operational commands, but also at the training level, to reduce the amount of time spent retraining individuals who cannot complete BUD/S with the class in which they are enrolled.

The United States Navy SEAL teams today, attached to one of two Naval Special Warfare Groups, are derived from the Underwater Demolition Teams (UDTs) that were established as a result of World War II. The origin of the SEALs dates back to volunteers organized into Navy Combat Demolition Units (NCDUs) in 1943. Over the years the mission of the SEALs, although referred to under different names at various points in time, has virtually remained the same: to conduct unconventional warfare, counter-guerilla warfare and clandestine operations in both blue and brown water environments - the requirement for hydrographic reconnaissance and underwater demolition. [Ref. 3]

SEAL teams undergo what is considered the most selective screening process and ultimately the most extensive military training in the world. Selection to this prestigious, challenging community is a major accomplishment for enlisted personnel and officers alike. Once selected, the largest and most difficult obstacle to overcome is graduation from the BUD/S training program at Naval Special Warfare Center (NSWC), Coronado, California. [Ref. 3]

During BUD/S students encounter obstacles that develop and test their stamina, leadership and ability to work as a team. The training program is designed to push the individual beyond what is considered the normal limits of physical and mental abilities for the purpose of keeping only those mentally and physically strong enough to perform under the most extenuating circumstances - those which would be present during combat situations.

BUD/S is composed of three training phases: (I) Basic Conditioning (nine weeks), (II) Diving (seven weeks), and (III) Land Warfare (nine weeks). Phase I consists of physical conditioning in the areas of running, swimming, calisthenics, obstacle courses, and small boat seamanship. The first five weeks prepare trainees for week six, better known as "hell-week". During hell-week, students undergo five and one-half days of continuous extensive physical training with a maximum of four hours of sleep. During this week, the men are pushed beyond limits, not only from extreme mental and physical pain and exhaustion from the activities themselves, but also from sleep deprivation. The last three weeks of Phase I teaches methods of conducting hydrographic surveys and charts. Physical training continues in Phase II but the requirements must be met in half the amount of time as in Phase I. Phase II focuses on combat Self Contained Underwater Breathing Apparatus (SCUBA), including both open circuit (compressed air) and closed circuit (100% oxygen). The emphasis is toward basic combat diving techniques - using swimming and diving to transport SEALs from launch point to combat object - a skill that separates the Navy SEALs from all other Special Operations Forces. Phase III continues with physical training, with time requirements even further reduced, and concentrates on land navigation, small unit tactics, patrolling, rapelling, infantry tactics, and military explosives. The last five weeks are spent on San Clemente Island where techniques acquired are applied to real life situations. [Ref. 3]

After graduation from BUD/S, graduates undergo basic parachute training at the Army Airborne School, Fort Benning, Georgia. Navy corpsmen who complete this training also attend two weeks of Special Operations Technical Training at Naval Special Warfare Center, Coronado, CA, to receive instruction in diving medicine and medical skills and 44 weeks additional training at Fort Bragg, NC. [Ref. 3]

Upon completion of the above training, both enlisted and officer personnel report to one of the Naval Special Warfare Commands as part of a SEAL team where they are placed in a probationary status for six months. The Commanding Officer, in accordance with Military Personnel Manual (MILPERSMAN) articles 1410380 (enlisted) and 1420160 (officer), recommends official selection to the Navy SEALs. If selected, enlisted personnel are awarded a Naval Enlisted Classification (NEC) Code, officers are given the appropriate designator, and both are awarded the "trident" insignia, which is only worn by SEALs.

2. Files Generated by MADSYS

A software system, the Medical Analytic Data System (MADSYS), was a temporary source of data collection for researchers at NHRC to closely examine effects of MS injuries on NSW personnel. The data were collected at NSWG-TWO Medical and released to Dr. Prusaczyk for use in this thesis. Understanding the construction of the database and rearranging the data into a more manageable form for analysis in this thesis provided the focal point for research during the experience tour at NHRC.

The MADSYS software system was written using relational data bases. Such a design "links" output files generated by a particular index, in this case, "NDXDEMO", which is an index starting at number 101 and representing an identifiable code (much like a social security number) of a particular patient.

Six output files generated by the system as Database (*.dbf) files are the primary files used in this thesis. Fields common to most files are:

- NDXDEMO - patient identifier.
- NDXVIST - visit index representing visit number which is unique to particular patient with a particular visit.
- NDXDIAG - diagnosis index indicating a diagnosis number unique to a particular patient with a particular diagnosis.
- NDXTRTM - treatment index representing a treatment number unique to a particular patient receiving treatment for a particular diagnosis.
- NDXDUTY - duty index representing a unique number in which a particular patient appears on a limited duty status for a particular diagnosis.
- ENCDATE - date of encounter of injury .

All the aforementioned index labels started with 101 and incremented by one. The names of the files, a sample output of each file, and descriptors of the fields in each file are given in Tables 2.1 - 2.6.

NDXDEMO	SSN	NAMEL	NAMEF	DOB	SEX	RACE	BRANCH	DATEDEMO
101	000-00-0000	DOE	JOHN	19-08-70	1	1	1	02-01-96
102	111-111-111	SMITH	SAM	09-11-63	1	1	1	02-01-96
103	222-22-2222	DOE	MIKE	24-04-67	1	3	1	02-01-96

SEX:	RACE:	BRANCH:	
1 = Male	1 = White	1 = Navy	4 = Army National Guard
2 = Female	2 = Black	2 = Marine Corps	5 = Air Force
		3 = Other	6 = Other

Table 2.1 *Maddemo.dbf* Sample File with Descriptors

NDXDEMO	NDXVIST	ENCDATE	CLINIC	VISTYPE	ICDTYPE	INJTYPE	INJMECH	ACTCATE	ACTSPEC
101	103	03-01-96	1	1	3	4	3	1	1
102	101	03-01-96	1	1	1	4	3	1	1
102	3829	05-11-96	1	1	1	3	1	4	2

CLINIC:	VISTYPE:	INJMECH:	INJTYPE:	ICDTYPE:
1 = Regular	1 = Initial	1 = Overuse	1 = New	1 = Training/MS
2 = Physical Therapy	2 = Follow-up	2 = Acute	2 = Recurrent	2 = Training/Other
3 = Sports Medicine	3 = Other	3 = N/A	3 = Chronic	3 = Nontraining/MS
4 = Athletic Trainer	4 = Unknown		4 = N/A	4 = Nontraining/Other
				5 = Other

ACTSPEC:			
1 = N/A	5 = O Course	9 = Fastrope	13 = Patrolling
2 = Running	6 = Weightlifting	10 = Rapelling	14 = Boat Ops
3 = Swimming	7 = Para Ops/Static	11 = Climbing	15 = Diving
4 = Calisthenics	8 = Para Ops/FF	12 = Skiing	16 = Other

Table 2.2 *Madvist.dbf* Sample File with Descriptors

NDXDIAG	ENCDATE	DIAGCODE	DIAGDESC	DIAGSPEC	DIAGDATE
150	17-01-96	739300000	SOMATIC DYSFUNCTION	LUMBAR/PELVIS	16-01-96
151	17-01-96	9930A0000	RUPTURE - ROUND WINDOW	PARALYMPHATIC FISTULA	17-01-96
152	18-01-96	726191000	IMPINGEMENT SYNDROME	R SHOULDER	17-01-96

DIAGCODE:	DIAGDESC:	DIAGSPEC:
Represents Standard ICD9Code	Diagnosis Description	Diagnosis Specific

Table 2.3 *Maddiag.dbf* Sample File with Descriptors

NDXDEMO	NDXHIST	RANK	UNITCATE	OPSTAT	HISTDATE
103	103	13	2	1	02-01-96
104	104	6	7	3	02-01-96
105	105	4	5	3	02-01-96

RANK:	UNITCATE:	OPSTAT:
1 - 9 = E-1 through E-9	1 = ST-2	1 = Platoon
10 = Warrant	2 = ST-4	2 = Operator
11 - 13 = O-1 to O-3	3 = ST 8	3 = Support
14 = O-4 to O-6	4 = SDV TM-2	4 = Other
15 = N/A	5 = GRU-2	
	6 = SBU-2	
	7 = Other	

Table 2.4 *Madhist.dbf* Sample File with Descriptors

NDXDEMO	NDXVIST	NDXDIAG	NDXTRTM	TRTMCATE	TRTMDATE
110	111	109	106	1	05-01-96
110	111	109	107	6	05-01-96
112	115	112	108	9	09-01-96

TRTMCATE:

1 = e-stim	6 = Cryotherapy	11 = Other
2 = Hydrotherapy	7 = KIN COM	
3 = Ionophoresis	8 = Hot Packs	
4 = Ultrasound	9 = Exercises	
5 = Phonophoresis	10 = OMT	

Table 2.5 *Madtrtm.dbf* Sample File with Descriptors

NDXDEMO	NDXVIST	NDXDIAG	NDXDUTY	DUTYSTAT	STRTDATE	STOPDATE
146	151	149	141	1		
147	152	151	142	4	17-01-96	17-07-96
148	153	152	143	10	18-01-96	25-01-96

DUTYSTAT:

1 = Full	5 = No upper body	9 = No swim w/fins
2 = No Duty	6 = No lower body	10 = No Lifting
3 = No Jump	7 = No soft sand	11 = Limit weight bearing
4 = No Dive	8 = No swim	

Table 2.6 *Madduty.dbf* Sample File with Descriptors

B. DATA EDITING/CORRECTION

1. Creation of a Single Treatment File

One drawback in using the output files generated by MADSYS is the fact that information about a particular patient has to be viewed separately from file to file. In order to conduct the appropriate analysis of these data, it was necessary to retrieve the pertinent information from each file and combine it properly into one file, known as the *treatment* file. This required determining the index link which, as stated earlier, is the patient identifier, "NDXDEMO". Three files, *Madtrtm.dbf*, *Madvist.dbf*, and *Maddemo.dbf* were imported from Microsoft Excel, Version 5.0, as tables into Paradox running from Windows 3.1. A query was then created to build one file with the necessary information from the three files. The "join tables" command was used joining the fields

NDXDEMO, NDXVIST, NDXTRTM, and NDXDIAG. A sample output of the resulting *treatment* file is given in Appendix A.

2. Editing the Treatment File

While checking the accuracy of the data, it was determined that some records associated with follow-up visits in the *Madvist.dbf* file were not correct. When opening an existing file for a patient in MADSYS, there is an option to select "2" for "follow-up for existing condition". When selected, a screen appears in which the person entering data may select the diagnosis code for which the follow-up visit exists. Once the diagnosis code is chosen, it appears, by viewing the screen, that the former existing information for that diagnosis (injury type, injury mechanism, etc.) is selected. However, unless the person entering the data physically reselects all that information by a click of the mouse in those fields, the default selections for the last five fields appear in the *Madvist.dbf* file as follows:

NDXDEMO	NDXVIST	ENCDATE	CLINIC	VISTYPE	ICDTYPE	INJTYPE	INJMECH	ACTCATE	ACTSPEC
138	186	30-01-96	4	2	1	1	1	1	1

Thus, it appears as though the last five fields were all entered as "1".

Approximately 60 percent of all follow-up visits did not reveal the correct information. Therefore, the *match* command in S-Plus was used to match all the follow-up visits in the *treatment* file to their corresponding initial visits in the *Madvist.dbf* file. The incorrect information in the *treatment* file was then replaced by the correct information from the *Madvist.dbf* file.

3. Lost Data

Some of the follow-up visits did not have an initial visit associated with them. It was determined previously that the system had failed several times throughout the course of the thirteen month period of data collection. Because the system had no automated timed-backup saving feature, some of the data were lost. Whenever possible, Brandi Schober, who entered all of the data at NSWG-TWO Medical, would re-enter the data and/or corroborate what the initial information should be. However, it is unknown whether all of the lost data were retrieved.

4. Retrieving MS Injury Data Incurred by Navy SEALs

Because data retrieved from NSWG-TWO Medical were collected for all patients and dependents entering clinics at the command, it was necessary to extract only the data of interest in this thesis; namely, the MS injuries incurred by those patients who are Navy SEALs. A description of ICD-9 Codes [Ref. 4], standard diagnosis codes utilized by all major medical facilities and hospitals, together with [Ref. 5] were used to determine which types of diagnosis codes affected the MS system. Because the standard ICD-9 Codes reflect both MS system diseases/injuries which are extrinsic and intrinsic, it was necessary to extract only the extrinsic diagnoses. This is because researchers at NHRC are primarily concerned with those MS injuries which result from extensive overuse or changes in training schedules and exercise, because those are the injuries which may be avoided with proper training. Once determined, only those records which reflected extrinsic MS injuries were retrieved from the existing *treatment* file. Of those records, only the patients who are Navy SEALs (indicated by an entry of 1 or 2 in the OPSTAT field of the *Madhist.dbf* file) were retrieved.

5. Changing the Date Format

The final step in editing the updated *treatment* file was to change the date format. MADSYS generated dates in the format 03-01-96 representing the date January 3, 1996. Because neither Microsoft Excel nor S-Plus (the two software packages utilized in this thesis) recognized this format as a date format, a macro was written in Microsoft Excel, version 5.0, to change the date format to 1/3/96, which is recognized by both software packages. A copy of the macro, Function *fixdates* is given in Table 2.7.

There was no interest in retrieving the records in the *Madduty.dbf* file for which a patient was given a "full" duty status. (It is important to note that not all patients who did not receive a limited duty status received a "full" duty status). Therefore, only the records from that file with entries in the DUTYSTAT field not equal to "1" were extracted. The new file was named *limduty*. Both the new *treatment* and *limduty* files were the two baseline files used to proceed in determining the man-days lost over time as a result of MS injuries incurred by Navy SEALs.

```
Function fixdate(indate As Variant) As String
which = Mid(indate, Len(indate) - 2, Len(indate) - 2)
If which = "-" Then
  fixdate = Mid(indate, 4, 2) & "/" & Mid(indate, 1, 2) & "/" & Mid(indate, 7, 2)
Else
  myyear = Right(indate, 2)
  inlen = Len(indate)
  If (Mid(indate, inlen - 4, 1) = "/") Then 'month has one digit
     mymonth = Mid(indate, inlen - 3, 1)
     myday = Left(indate, inlen - 5)
  Else
    mymonth = Mid(indate, inlen - 4, 2)
    myday = Left(indate, inlen - 6)
  End If
  fixdate = mymonth & "/" & myday & "/" & myyear
End If
End Function
```

Table 2.7 Function *fixdates*

C. IMPACT ON OPERATIONAL READINESS

Musculoskeletal injuries have been identified specifically by the NSW community as a high-priority topic for research. During Operation Desert Storm, MS injuries were the second most common cause of troop morbidity. At the 1991 and 1992 NSW Biomedical Research Conference, exercise-related injuries were listed as the top priority for future medical/physiological research. In fact, seven of the eight NSW commands listed exercise-related injuries as the most important problem needing attention. In a NHRC survey of East (N=88) and West (N=84) Coast SEALs, exercise-related injuries were among the top three areas targeted for biomedical research. [Ref. 2: p. 10]

Obviously, because of the extensive screening and selection process, training and subsequent requirements to complete BUD/S and earn the "trident" insignia, the Navy SEALs are considered an elite group within the special operations forces and the Navy itself. Because so many men may initially be eligible but so few are selected, the Navy is obligated to ensure that these highly trained SEALs can perform in the event of combat to the fullest of their abilities.

Fiscal Year 1997 authorization for Navy SEALs was just over 2000 men. It is conceivable, therefore, that man-days lost due to injury of Navy SEALs has a much greater impact on operational readiness than loss by other groups because of the small population size.

D. THESIS ORGANIZATION

Chapter III describes the process by which steps were taken to compute the crucial measure of effectiveness (MOE): man-days lost over time (for specified missions and mission segments) as a result of MS injuries incurred by Navy SEALs. The procedure entails a new database which was created that represents all the SEALs out on a particular day due to limited duty restriction(s), as a result of receiving treatment , or both. A description of how MS diagnosis codes were "mapped" to particular limited duty codes (such as "no duty", "no lower body", "no upper body") as given in the *Madduty.dbf* file is provided. Discussion continues with selection of specific missions and mission segments, and finally, with development of functions to compute the MOE.

Chapter IV contains the graphical and statistical results obtained by implementing the methodology described in Chapter III.

Chapter V provides NHRC with recommendations and suggestions for future data items to be collected in order to more accurately compute the MOE. This chapter also provides suggestions for ongoing and future research.

III. METHODOLOGY

A. DATA COLLECTION ISSUES/ASSUMPTIONS

Musculoskeletal injury data for Navy SEALs at NSWG-TWO were to be used as the data set to determine the impact on the MOE: Man-days lost over time due to MS injuries incurred by Navy SEALs. However, it was determined that these data are not sufficient to answer the question. To further illustrate the point, recall the data provided when a SEAL visits a clinic for a particular injury:

NDXDEMO	NDXVIST	ENCDATE	CLINIC	VISTYPE	ICDTYPE	INJTYPE	INJMECH	ACTCATE	ACTSPEC	VISTDATE
102	101	03-01-96	1	1	1	4	3	1	1	02-01-96

Several important pieces of information are missing. For example, there is no healing time estimate for the injury. Nowhere is it recorded that the patient is required to return for physical therapy for three weeks. The only information provided involving time is the actual date of the visit and the date of the last visit for the same diagnosis (not shown above).

There are some instances where patients are given a limited duty status which is output to the separate *Madduty.dbf* file. Recall the pre-defined categories for limited duty status that appeared in the *Madduty.dbf* file generated when the duty status portion was completed by the reviewing physician:

DUTYSTAT:		
1 = Full duty	5 = No upper body	9 = No swim w/fins
2 = No duty	6 = No lower body	10 = No lifting
3 = No jump	7 = No soft sand	11 = Limit weight bearing
4 = No dive	8 = No swim	

The limited duty is related to the specific activity that should not be performed. However, as seen above, the DUTYSTAT information recorded is not the same as the information regarding types of activities in which injury may be sustained:

ACTSPEC (activity specific):			
1 = N/A	5 = O Course	9 = Fastrope	13 = Patrolling
2 = Running	6 = Weightlifting	10 = Rapelling	14 = Boat Ops
3 = Swimming	7 = Para Ops/Static	11 = Climbing	15 = Diving
4 = Calisthenics	8 = Para Ops/FF	12 = Skiing	16 = Other

For example, a patient with an ankle sprain may be told by the physician not to run or jump for two weeks, but "no running" does not appear as a duty status category. Thus, some consideration was given to make the activity and limited duty status categories reflect the same information, which could also easily be tracked to each of the missions and mission segments used during the analysis. As a result, a twelfth DUTYSTAT category was created: "12" for no running/walking with additional stress factors (such as carrying a 100 lb pack while trying to walk). This category was necessary because almost all of the missions and mission segments performed by SEALs result in walking under very stressful conditions. Although running seldom appears in the description of missions and mission segments (provided for use in this thesis) performed by SEALs, it is conceivable that this activity may be necessary when performing missions during combat operations. For purposes of this thesis, the other types of training activities which should not be performed (such as rapelling, fastroping, etc.), were not given limited duty status codes, since the database is a reflection of SEALs injured while in an operational status. However, this type of information is easily added to reflect any environment impacting the MOE.

A patient given limited duty status for two weeks may have continued to see a physical therapist every day for three months. This implies that although no longer limited in duty, the healing process actually was not complete. Clearly, the individual expected to engage in these activities during combat would not have the luxury of being treated by physical therapy on a daily basis and may not be able to perform this activity (or perform the activity to his maximum ability). This would certainly affect his ability to perform any of the missions or mission segments which require use of the particular activity. For purposes of this thesis, it was assumed that an individual receiving treatment for a time period, but not given a limited duty status, would only be able to perform the activity at 50 percent of his normal ability, while those on limited duty would not be able to perform the activity at all. The percent effectiveness of individual performance can easily be changed by anyone using the database to compute the MOE.

It is unknown whether the last visit for a patient with a particular diagnosis indicates the patient has actually been healed, is no longer part of the command, or if that was the last visit for that diagnosis before data collection ceased. Because this information was not available, it was assumed that the patient's duration of treatment for particular injury started at the time of his diagnosis and ended with his last visit for that diagnosis.

B. CREATION OF TREATMENT/LIMITED DUTY DATABASE

1. Treatment and Limited Duty Files

Two files which already existed, the *treatment* and *limduty* files, were modified for ease and efficiency of computation. For instance, the *treatment* file showed every visit for which a patient received treatment for each diagnosis, resulting in the same information being repeated, with the exception of the date of visit. As mentioned earlier, the assumption was that the duration of treatment was from the time of diagnosis for injury through the last treatment for the diagnosis. A function, *diag.days* (see Table 3.2), was written in S-Plus to query the *treatment* file for "START" and "STOP" dates of treatment, and to call another function, *todate* (see Table 3.1) to change the date format

```
function(mmddyy.vec)        {
# Convert a date like 1/13/95 into a number like 950113.
                result <- numeric(length(mmddyy.vec))
                for(i in 1:length(mmddyy.vec)) {
                                mmddyy <- mmddyy.vec[i]
                                nc <- nchar(mmddyy)
                                yy <- as.numeric(substring(mmddyy, nc - 1, nc))
                                if(substring(mmddyy, nc - 4, nc - 4) == "/") {
# one-digit day                                         dd <- as.numeric(substring(mmddyy, nc - 3, nc - 3))
                                                        if(nc > 6)
                                                                        mm <- as.numeric(substring(mmddyy, 1, 2))
                                                        else mm <- as.numeric(substring(mmddyy, 1, 1))
                                }
                                else {
                                                        dd <- as.numeric(substring(mmddyy, nc - 4, nc - 3))
                                                        if(nc > 7)
                                                                        mm <- as.numeric(substring(mmddyy, 1, 2))
                                                        else mm <- as.numeric(substring(mmddyy, 1, 1))
                                }
                                result[i] <- yy * 10000 + mm * 100 + dd
                }
                return(result)
}
```

Table 3.1 Function *todate* used to change date format to "yymmdd"

from "mm/dd/yy" to "yymmdd". All index categories and diagnosis codes were retrieved. The resulting file was named *trtdays* (see Appendix B).

```
function(data = treatment)
{
        cols <- c("NDXDEMO.2", "NDXDIAG.1", "DIAGCODE", "First", "FirstSrc", "Last", "LastSrc",
                Diff)
        result <- matrix(0, length(unique(data[, "NDXDIAG.1"])), length(cols))
        dimnames(result) <- list(NULL, cols)
        result <- as.data.frame(result)
        u.diag <- unique(data[, "NDXDIAG.1"])
        for(i in 1:length(u.diag)) {
                cat("Working on diagnosis ", u.diag[i], "\n")
                rows <- (1:nrow(data))[data[, "NDXDIAG.1"] == u.diag[i]]
                first.row <- data[rows[1],  , drop = F]
                vec <- c("NDXDEMO.2", "NDXDIAG.1")
                result[i, vec] <- first.row[vec]
                result[i, "DIAGCODE"] <- as.character(as.vector(first.row["DIAGCODE"]$DIAGCODE))
                e.date <- todate(as.character(data[rows, "ENCDATE"]))
                d.date <- todate(as.character(data[rows, "DIAGDATE"]))
                overall.min <- min(e.date, d.date)
                overall.max <- max(e.date, d.date)
                result[i, "First"] <- overall.min
                result[i, "Last"] <- overall.max
                if(min(e.date) < min(d.date))
                        result[i, "FirstSrc"] <- "Enc"
                else result[i, "FirstSrc"] <- "Diag"
                if(max(e.date) > max(d.date))
                        result[i, "LastSrc"] <- "Enc"
                else result[i, "LastSrc"] <- "Diag"
                min.yy <- trunc(overall.min/10000)
                max.yy <- trunc(overall.max/10000)
                min.mm <- trunc((overall.min - 10000 * min.yy)/100)
                max.mm <- trunc((overall.max - 10000 * max.yy)/100)
                min.dd <- overall.min - 100 * as.integer(overall.min/100)
                max.dd <- overall.max - 100 * as.integer(overall.max/100)
                yys <- max.yy - min.yy
                mms <- max.mm - min.mm
                dds <- max.dd - min.dd
                if(mms < 0) {
                        mms <- mms + 12
                        yys <- yys - 1
                }
                if(dds < 0) {
                        mms <- mms - 1
                        dds <- dds + 30
                }
                result[i, "Diff"] <- paste(format(c("12", yys)[2]), "/", format(c("12", mms)[2]),
                        /, format(c("12", dds)[2]), sep = "")
        }
        return(result)
}
```

Table 3.2 Function *diag.days* used to create a treatment file with start and stop dates

The *limduty* file already had fields containing the "START" and "STOP" dates of limited duty, but did not record the diagnosis code. This additional information was

appended to the *limduty* file using the *match* function in S-Plus, which matched each diagnosis index (NDXDIAG) in the *limduty* file to the same diagnosis index in the *trtdays* file (since the NDXDIAG is unique to each patient). Sample output for each of the files can be seen in Tables 3.3 and 3.4. Note that the last column of the *trtdays* file, "Diff", represents the total time in treatment in "years/months/days".

NDXDEMO	NDXDIAG	DIAGCODE	First	FirstSrc	Last	LastSrc	Diff
102	981	726691000	961102	Diag	961107	Enc	0/0/5
112	112	71946A000	960108	Diag	960223	Enc	0/1/15
113	113	739300000	960108	Diag	960423	Enc	0/3/15

Table 3.3 Sample output of *trtdays* file

NDXDEMO	NDXVIST	NDXDIAG	NDXDUTY	DUTYSTAT	START	STOP	DIAGCODE
115	118	115	112	6	951204	960109	924200000
122	126	121	119	10	960111	960121	847100000
128	133	129	124	7	960112	960126	726691000

Table 3.4 Sample output of *limduty* file

2. Database Design

The design of the database to be used for computing the MOE must show, for each day for which data were collected, the individuals who were in treatment and/or on limited duty for a particular diagnosis. The dates of data collection were from December 4, 1995 through February 11, 1997 (951204 - 970211).

There is also the need to separate the treatment information from the limited duty information when performing computations. Therefore, three pertinent pieces of information are retrieved from each of the *trtdays* and *limduty* files:

- Patient identifier, *Demo*.
- Category, *Cat*, "T" representing the data were retrieved from the *trtdays* file or "D" indicating retrieval from the *limduty* file.
- Diagnosis code, *Diagcode*.

A function *make.table* (see Table 3.5) was written in S-Plus to retrieve, for each day, the three field records first from both the *trtdays* and *limduty* files. The table was created by a call to another function, *out* (see Table 3.6) also written in S-Plus. The primary purpose of the *make.table* function is to keep track of the days of the month in the database and rely on "out" to "make the table". The result was a non-rectangular database

consisting of each row representing a day. Each row contained the new date in "yymmdd" format, followed by the three field records for all the "T" categories, followed by the three field records for all the "D" categories.

```
function()
{
# Calls function "out" to look for patients receiving treatment and/or on limited duty status for each day
# "Out" passes back a row vector for each day containing the date and 3 field records
# Make table of IDS of SEALs out because of their being
# on actiuve treatment or limited duty, by date, two
# columns per day of 1996.
        today <- 951204
        moday <- data.frame(Mo = 1:12, Days = c(31, 29, 31, 30, 31, 30, 31, 31, 30, 31, 30, 31))
        yy <- 95
        mm <- 12
        dd <- 4
        i <- 1
        repeat {
                cat("Date is now ", today, "\n")
                cat(out(today))
                if(today >= 970211) {
                        break
                }
                i <- i + 1
                today <- today + 1
                dd <- dd + 1
                if(dd > moday[moday[, "Mo"] == mm, "Days"]) {
                        dd <- 1
                        mm <- mm + 1
                        if(mm > 12) {
                                yy <- yy + 1
                                mm <- 1
                        }
                        today <- 10000 * yy + 100 * mm + dd
                }
        }
}
```

Table 3.5 Function *make.table* used to create the *dutyntrt* file

```
function(day)
{
# Out: Which SEALs are out on a given date?
# argument: day, the relevant date in yymmdd format.
# This function looks at the two tables "limduty" and
# "trtdays" and produces a vector of ID numbers
# (from NDXDEMO) of people out on this day.
        trtvec <- trtdays[, "First"] <= day & trtdays[, "Last"] >= day
        badt.ttt <- trtdays[trtvec, "NDXDEMO"]
        diagt.ttt <- as.character(as.vector(trtdays[trtvec, "DIAGCODE"]))
        ldutyvec <- limduty[, "START"] <= day & limduty[, "STOP"] >= day
        badt.duty <- limduty[ldutyvec, "NDXDEMO"]
        diagt.duty <- as.character(as.vector(limduty[ldutyvec, "DIAGCODE"]))
        if(sum(trtvec) == 0)
                ttvec <- NULL
        else ttvec <- paste(",T", badt.ttt, diagt.ttt, sep = ",", collapse = "")
        if(sum(ldutyvec) == 0)
                ldvec <- NULL
        else ldvec <- paste(",D", badt.duty, diagt.duty, sep = ",", collapse = "")
        paste(day, ttvec, ldvec, "\n", sep = "")
}
```

Table 3.6 Function *out* used to obtain data on SEALs out each day

The resulting database in S-Plus was "dumped" from S-Plus, because it was not a rectangular table (since the number of patients in treatment and/or on limited duty status is not necessarily the same from day to day). This was done using the following commands at the prompt:

```
> sink ("c:/snowth~1/dutyntrt")  # allocates space for file in snowthesis directory
> make.table ()                  # creates file
> sink ()                        # copies the file to snowthesis directory
```

These commands allow the user to open the file (*dutyntrt*) created using any applicable software package. This particular file was opened in Microsoft Excel. Because the total length of each row was unknown, no category headings were assigned prior to opening the file in Excel. Category headings were inserted into the file in Excel. In order to perform future computations in S-Plus, it was necessary to retrieve the file from Excel. However, S-Plus does not recognize non-rectangular tables. Therefore "dummy" records were inserted in order to make the file readable in S-Plus. The "dummy" records would prove useful later (in terms of efficiency and run-time) in searching the *dutyntrt* file for

individual records. This is because during the search, once a dummy record was encountered on a particular row, that row would be exited and the search would proceed to the next row. The updated *dutyntrt* file was read into S-Plus using the *read.table* command. Sample output of the created database, *dutyntrt*, is given in Table 3.7. A dummy records appears in the last three fields of row one in the sample output.

Day	Cat	Demo	Diagcode	Cat	Demo	Diagcode	Cat	Demo	Diagcode	Cat	Demo	Diagcode
951231	T	115	924200000	T	252	8310A0000	D	115	924200000	N	999	99999
960101	T	115	924200000	T	252	8310A0000	D	115	924200000	D	215	822000000
960102	T	115	924200000	T	212	844200000	T	252	8310A0000	D	115	924200000

Table 3.7 Sample output of *dutyntrt* file

C. MAPPING DIAGNOSIS CODES TO LIMITED DUTY (LD) CODES

In order to determine how the SEALs with particular diagnoses on a given day affect performance of specific missions and mission segments, it was first necessary to determine how each of the diagnosis codes affects an individual's ability to perform the specific activities involved. These activities include those for which the individual is given limited duty status (jumping, diving, upper body, lower body, etc.). Of course, the manner in which a certain injury affects an individual varies with each individual. In fact, it is possible that one person with a particular injury would still be able to perform an activity with limited capability while another may not be able to perform the activity at all. However, since this type of information - *specific to each individual sustaining injury* - was not available, a more subjective approach was taken in order to determine how each of the diagnosis codes could affect each of the LD codes.

First, all the unique diagnosis codes were extracted from the *treatment* and *limduty* files. They were then imported into a file, *unqcode.xls*, in Microsoft Excel. Each row label was a diagnosis code (in ascending order) and each column label was "LD2" through "LD12" representing the limited duty status categories "2" through "12". Previous information obtained from patients given limited duty status was used to assist in the determination of which diagnoses affect which activities (e.g, a majority of the back injuries resulted in "no lower body"). Therefore, the assumption was made that those back injuries which resulted in a patient being unable to use his lower body could (in a worst case scenario) affect any individual with the same back injury. Keep in mind that it is possible that any of the injuries *could* result in "no duty", "no lower body" or "no upper

body". However, in order to obtain a more realistic mapping from diagnosis to LD code, only those injuries which were the most severe, such as injuries associated with the vertebral column, were assumed to result in "no duty" (LD code 2). The same approach was used to determine which diagnoses *could* result in "no upper body" (LD code 5) and "no lower body" (LD code 6). These three limited duty status categories were of particular importance because they are the ones which result in the largest fraction of man-days lost over time due to MS injuries.

In cases where no previous information existed to aid in determining the mapping, both [Ref. 5] and Brandi Schober (physical therapist who entered all data at NSWG-TWO) provided valuable insight and information as to which types of injuries could potentially result in which types of limited duty activities. Each diagnosis was investigated in [Ref. 5] to determine the exact muscles and joints affected by the MS injury.

One particular code, "V67000000", referring to *post surgical procedure* does not indicate for which injury the surgery was performed. Therefore, it is necessary to extract the patient records from the *limduty* and *treatment* files where this code appears and compare the information to that in the *Maddiag.dbf* and *Madvist.dbf* files to replace that code with the code for which the surgery was required. Any records in the files for which these codes resulted in a *non-musculoskeletal* injury were removed from the two files.

Once the determination was made as to which diagnosis codes mapped to particular LD codes, the next step was to reflect this information in the *unqcode* file. This was done by assigning a "1" in the column of the LD codes in which the corresponding row entry, diagnosis code, could affect it; otherwise, a zero was assigned. This is, of course, comparable to a Bernoulli distribution where success (1) indicates the LD code is affected by the diagnosis code, or failure (0) which indicates no effect. It is important to note that this information was determined in the best manner possible, *given the current database*. Any determination of an injury potentially resulting in an LD code which is not reflected in the file can easily be changed by the user.

The resulting *unqcode.txt* file was read into S-Plus and saved as object *unqcode* (see Appendix C). A sample output of the file is shown in Table 3.8.

DIAGCODE	LD2	LD3	LD4	LD5	LD6	LD7	LD8	LD9	LD10	LD11	LD12
729000000	0	1	0	0	1	1	0	0	0	0	1
715970000	0	1	0	0	0	1	0	1	0	0	1
719410000	0	0	1	0	0	0	1	1	1	0	0

Table 3.8 Sample output of *unqcode.txt* file

D. CREATION OF TABLES FOR EACH LD CODE

The next step was to write a function in S-Plus which showed all the patients who would be affected by each of the LD codes on a given day. Again, the assumption was that each diagnosis would result in either the inability or limited ability of the individual to perform those activities that the particular diagnosis would affect. For example, as seen in Table 3.8, the diagnosis code "729000000" could affect LD codes 3, 6, 7, and 12, which means it could result in "no jumping", "no lower body", "no soft sand", or "no running" (or a limited ability to perform these). It was necessary to determine which patients were put on limited duty and/or received treatment for a particular injury for *each* LD code (i.e, which patients were affected by "no jumping" as a result of being put on limited duty status or by "limited ability to jump" as a result of receiving treatment).

A separate function was written for each LD code which would search the *dutyntrt* file each day. This was done not only to query the *dutyntrt* file for one LD code at a time, allowing for timeliness in search, but also to allow for ease of editing records in any one table. For example, suppose it was discovered that an error had been made in column three of the *unqcode* file. Only those patients affected by LD code 3 would change. A separate function for each LD code allows the user to correct the information in the *unqcode* file and rerun the function without having to change any of the other tables already created. For every three field record (*Demo, Cat, Diagcode*), the function searches the *unqcode* file for that particular diagnosis code and outputs a four field record *(Day, Demo, Cat, Diagcode*) for each patient affected by that particular LD code. For example, function *ldtable2* searches the *dutyntrt* file for all the patients affected by LD code 2 and outputs the four field record into a table called *table2*. Each function was named *ldtableX*, where X represents the appropriate LD code number. Each function would return *tableX* ,where X is as defined above. Each of the tables returned are given column headings and saved as *ldrX.out* (LD results), where X is defined above. Function *ldtable2* is given in Table 3.10. A sample output of the table *ldr2.out* is given in Table 3.9.

Day	Cat	Demo	Diagcode
960212	T	204	724502000
960220	T	231	721900000
960220	D	231	721900000

Table 3.9 Sample output of *ldr2.out*

Next, each of the *ldrX.out* files are "filtered" in S-Plus to obtain all those with category "T" separate from all those with category "D". Each is saved as *ldrXt.out* (those on limited duty X) or *ldrXd.out* (those affected by limited duty X but receiving treatment). Before any computations of man-days lost over time for any of the missions and mission segments are made, it is necessary to determine which missions and mission segments are required.

```
function(rowcodes, unqcode)
{
# rowcodes here is the dutyntrt file
# unqcode is the unqcode file
        t2.ctr <- 1
        table2 <- matrix(" ", nrow = 2500, ncol = 4)
        rowcodes.col <- ncol(rowcodes)
        for(i in 1:nrow(rowcodes)) {
                cat("Now on row ", i)
                j.seq <- seq(4, rowcodes.col, by = 3)
                js <- rowcodes[i, j.seq]
                js <- js[js != "99999" & js != "   99999"]
                j.seq <- seq(4, by = 3, length = length(js))
                samprows <- unqcode[as.logical(match(unqcode[, 1], js, 0)),  , drop = F]
                which.are.2 <- samprows[samprows[, 2] == "1", 1]
                if(length(which.are.2) != 0) {
                        cat("...found!\n")
                        j.seq <- j.seq[as.logical(match(js, which.are.2, 0))]
                        right <- cbind(i, c(rbind(1, j.seq - 2, j.seq - 1, j.seq)))
                        n <- length(j.seq)
                        left <- cbind(rep(t2.ctr:(t2.ctr + n - 1), rep(4, n)), rep(1:4, n))
                        table2[left] <- rowcodes[right]
                        t2.ctr <- t2.ctr + n
                }
                else cat("...nothing there\n")
        }
        return(list(table2 = table2))
}
```

Table 3.10 Function *ldtable2* to show all patients affected by LD code two

E. SEAL MISSIONS AND MISSION SEGMENTS

As previously mentioned, the next step in computing the MOE is to select a sample of several missions and mission segments performed by Navy SEALs. A study documented in [Ref 6] sought to determine, by interviewing 82 SEALs from NSWG-ONE

and NSWG-TWO having an average time in community of approximately 11 years, what types of activities and abilities were considered by SEALs to be the most crucial in performing certain missions and mission segments. The primary missions were categorized broadly as:

- Beach surveys in support of amphibious operations.
- Reconnaissance and intelligence gathering.
- Rescue of downed pilots and extraction of personnel from denied territory.
- Limpet (ordnance) attacks against enemy ships and piers.
- Direct actions against military targets on shore or at sea.

The missions are composed of several segments which include planning, transit, insertion, operation, extraction, and egress. Each segment requires specific, distinct activities that are integral components of the overall mission.

A survey questionnaire was answered by the participating SEALs. The survey questions concerned three areas of description:

- Missions.
- Mission segments.
- Thermal stress conditions (not used in this thesis).

Section (1) described 37 missions falling into five categories:

- Overland - 13 of primarily walking and carrying heavy loads.
- Across the Beach - 11 involving transit from a cold, wet environment to a cold, dry environment.
- Ship Attack - 6 limpet attacks incorporating varied insertion modes.
- Survey - 2 beach surveys.
- Other - 5 encompassing attack on an oil platform, equipment loading onto a submarine, and 3 combat missions for which SEALs received Medals of Honor.

Section (2) described 50 mission segments falling into four categories:

- Walking/hiking/skiing - 12 of primarily walking carrying heavy loads.
- Swimming/diving - 17 surface or underwater swimming using SCUBA.
- Lifting/dragging/carrying/climbing - 16 involving rescue carriers and carrying heavy equipment and climbing.
- Jumping/bumping - 5 using fast rope or parachute for insertion.

SEALs were asked three questions about each section and were instructed to record a number from a seven point Likert scale (values 1 - 7) that best reflected their

opinion and personal experiences. Example scale levels were of the form "easiest" (=1), "medium difficulty" (=4), and "most difficult" (=7) with intermediate values allowed. In addition, SEALs were asked about the frequency with which such missions were performed: "once per career", "once per year", or "once per month (or more)". SEALs were also asked to rank them in order of importance. Mean scores were computed for each of the categories (difficulty, frequency, and importance). Each mission and mission segment was ordered in terms of difficulty, frequency, and performance. An "overall criticality", the sum of the mean scores for each of the categories, was computed. All missions and mission segments as categorized above are given in Appendices B through I of [Ref. 6].

A few missions and mission segments which ranked high in two of the three categories (difficulty, frequency, importance) were selected for use in this paper. Also, the selection was made to result in some of the same activities, as well as some distinct activities, being used across the sample. The mission ranked highest in overall criticality, (referred to a Mission 1), was used in the sample because it ranked first in frequency, fifth in importance and was not considered very difficult to perform (ranked 31 of 37). The mission segment ranked highest in overall criticality (referred to as Mission Segment 1) was also a good candidate, since it did not use the same activities as Mission 1 and ranked first and eighth in frequency and difficulty, respectively. Mission Segment 3 (third in overall critically) was selected because it overlapped the swimming portion of Mission Segment 1 and ranked second and fifth in frequency and importance, respectively. One other mission was selected that required use of different activities from the previous mission and mission segments. As a result, Mission 25, although not ranked high in any of the three categories, was chosen primarily because it utilized different activities. A description of each mission and mission segment chosen is provided in Table 3.11. The percentages in parentheses at the end of each description represent the percentage of SEALs interviewed who actually performed the mission or mission segment.

Mission 1: Walk (hump) 15 km (9 miles) over uneven terrain at night carrying 125 pound pack (with radios, etc.) in 70° F temperature to objective; then, retrace steps to extraction point. (85 %)
Mission 25: Parachute (static line) into desert with 150 pound pack (day temp 110° F); then walk 75 km (47 miles) during the next 7 nights. (25 %)
Mission Segment 1: Swim for 3 hours underwater in 55° F temperature, wearing wet suit, mask fins, and using Drager UBA and attack board. (90 %)
Mission Segment 3: Swim/dive a distance of 2000 meters in 56° F water wearing wet suit, fins, and a Drager and carrying a limpet mine; then swim 2000 meters without the limpet mine. (89 %)

Table 3.11 Sample missions and mission segments used in analysis

F. COMPUTING THE MOE FOR EACH MISSION AND MISSION SEGMENT

Careful attention was required to assure that man-days lost were not double counted in the following situations:

- A patient receiving both a limited duty status and treatment for the same diagnosis on a given day.
- A patient receiving a limited duty status and/or treatment for one or more diagnoses on a given day.
- A patient affected by more than one LD code for any diagnosis on a given day (which is the case for every patient in the database, since every diagnosis is mapped to more than one LD code).

The easiest way to avoid recounting was to make pairwise comparisons, first between each of the *ldtables* affecting each particular mission or mission segment, then between those records involving patients out because of limited duty or treatment.

1. Comparison of LD Codes for Each Mission and Mission Segment

Mission 1 is used to describe the process steps in detail. It was determined that Mission 1 is affected by LD codes 2, 5, 6, 10, 11, and 12. As a result, the files *ldr2t.out*, *ldr5t.out*, *ldr6t.out*, *ldr10t.out*, *ldr11t.out*, and *ldr12t.out* are compared to each other to assure no duplicate counting in any of the "T" (treatment) categories. The comparable files *ldrXd.out* (X for 2, 5, 6, 10, 11, and 12) are compared to assure no duplicate counting in any of the "D" (duty) categories. Once all the pairwise comparisons [(2,5),

(2,6), (2,10), (2,11), (2,12), (5,6), (5,10), (5,11), (5,12), (6,10), (6,11), (6,12), (10,11), (10,12), and (11,12)] are made for all the *ldrXt.out* and *ldrXd.out* files, the most recent version of each of those are compared to each other to ensure an entry that appeared in both the "treatment" and "duty" tables for the same day would not be counted twice. Functions in S-Plus were written to make each of the pairwise comparisons separately and will be discussed later.

The first level of comparison [(2,5), (2,6), (2,10), (2,11), and (2,12)] required reading each of the two files to be compared and the addition of another column which indicated the LD code. For example, in comparing *ldr2t.out* and *ldr5t.out*, both files are read into function *m1t1* (for Mission 1 Treatment Step 1) and stored as *ldr2t* and *ldr5t*, respectively. Columns of "2's" and "5's", indicating that each record would be accounted for by LD code "2" and LD code "5", respectively, are added to the files. Since LD code 2 (no duty) would limit an individual more than any of the other codes, the *ldr2t* file is used as the main file (i.e., meaning it would not change, but other files may change). Each day present in the *dutyntrt* file is "looked for" in each of the two files. A comparison is made between all records in the *ldr2t* file and the *ldr5t* file for a given day. If any entry appears in both, then the entry "5" in column 5 of the *ldr5t* file was replaced by a "2" in order to signify it was already accounted for by the *ldr2t* file. Function *m1t1* is given in Table 3.12. Similar techniques are employed for each of the "first level" pairwise comparisons.

```
function(ldr2t.out, ldr5t.out)
{
# mission1 t1: deluxe version
# compares  the 2 files and places a "2"
# in column 5 if a record in ldr5t.out exactly matches one
# in ldr2t.out
                vec.2 <- apply(ldr2t.out, 1, paste, collapse = "")
                vec.5 <- apply(ldr5t.out, 1, paste, collapse = "")
                matchers <- match(vec.5, vec.2)
                ldr2t <- cbind(ldr2t.out, rep("2", nrow(ldr2t.out)))
                ldr5t <- cbind(ldr5t.out, rep("5", nrow(ldr5t.out)))
                new.col <- ncol(ldr5t)
                ldr5t[!is.na(matchers), new.col] <- "2"
                return(list(ldr2t = ldr2t, ldr5t = ldr5t))
}
```

Table 3.12 Function *m1t1* to compare "treatment" LD codes 2 and 5

Second level pairwise comparisons [(5,6), (5,10), (5,11), and (5,12)] were then made. For example, the function *m1t6* (Mission 1 Treatment Step 6) compares the most recent versions of the *ldr5t.out* (*m1out5t*) and the *ldr6t.out* (*m2out6t*) files. The most recent versions of each of those files now have five columns with either "2" or "5" in column five of the *m1out5t* file and either "2" or "6" in column five of the *m2out6t* file. Again, for each day, a comparison of records is made. If the same record (fields one through four) appears in both files, then the information is updated in the *m2out6t* file. In other words, if column five of the *m2out6t* file does not already contain a "2", then the "6" that is currently there is replaced by a "5" to indicate that it is already accounted for by the *m1out5t* file. Function *m1t6* can be seen in Table 3.13.

```
function(m1out5t, m2out6t)
{
# mission 1 t6: deluxe version
# Receives the first updated version of the file ldr5t.out (m1out5t)
# and compares it to most recent version of ldr6t.out (m2out6t); can
# only use apply on cols 1 thru 4 of m1out5t and m2out6t; places a "5"
# col 5 of m2out6t if that row exactly matches a row in m1out5t
                vec.5 <- apply(m1out5t[, c(1:4)], 1, paste, collapse = "")
                vec.6 <- apply(m2out6t[, c(1:4)], 1, paste, collapse = "")
                matchers <- match(vec.6, vec.5)
                ldr6t <- m2out6t
                new.col <- ncol(ldr6t)
               not2s <- ldr6t[!is.na(matchers),new.col] != 2
               # take the entries that haven't already been accounted
               # for in ld2 file and assign them a "5" in col 5
                ldr6t[(!is.na(matchers)) & (not2s), new.col] <- "5"
                return(list(ldr6t = ldr6t))
}
```

Table 3.13 Function *m1t6* to compare "treatment" LD codes 5 and 6

This process continues for the third, fourth and fifth level comparisons of all the *ldrXt.out* files and the same techniques are applied to all levels of comparison of the *ldrXd.out* files.

2. Comparison of "T" and "D" Type Files

The function *m1d2t2* (for Mission 1 Duty 2 versus Treatment 2) was written to compare the most recent versions of the *ldr2t.out* (*m1out2t*) and *ldr2d.out* (*m1out2d*) files. Both files are read into the function and renamed *ldr2t* and *ldr2d*, respectively. A

sixth column is then added to each file. Since the patients on limited duty are unable to perform specific activities, the *ldr2d.out* is treated as the "main" file. As a result, all records in the *ldr2d* file are assigned a "1" in column six to indicate that particular patient is counted as "out" for one day. Each record for each day is then compared between the two files. If there is no match of records for a day, a "1" is placed in column six of the *ldr2t* file (so that it is counted for that day in the *treatment* file). If there is a match of records for a given day, a "0" is placed in column six, indicating it has been accounted for by the *ldr2d* file. Function *m1d2t2* is given in Table 3.14. A sample output of the *ldr2t* file (named *m1trt2.out*) after completing the steps described above is given in Table 3.15.

```
function(m1out2t, m1dout2d)
{
# mission1: compare trmt ld2 to duty ld2
# to check for equal entries
# If the same person with the same diagnosis for
# a given day is put on limited duty and is seeking
# treatment, man-hrs lost will only be accounted for
# in the limited duty file; if he's only being treated
# man-hrs lost will be accounted for in the treatment
# file
        vec.2d <- apply(m1dout2d[, c(1, 3, 4)], 1, paste, collapse = "")
        vec.2t <- apply(m1out2t[, c(1, 3, 4)], 1, paste, collapse = "")
        matchers <- match(vec.2t, vec.2d)
        ldr2d <- cbind(m1dout2d, rep("1", nrow(m1dout2d)))
        ldr2t <- cbind(m1out2t, rep("T", nrow(m1out2t)))
        # if it does match, put a 0 where the T is in the trmt file
        new.col <- ncol(ldr2t)
        ldr2t[!is.na(matchers), new.col] <- "0"
        # if it does not match, put a 1 where the T is in the trmt file
        ldr2t[is.na(matchers), new.col] <- "1"
        return(list(ldr2d = ldr2d, ldr2t = ldr2t))
}
```

Table 3.14 Function *m1d2t2* to compare "treatment" and "duty" LD code 2

Day	Cat	Demo	Diagcode	Ldcode	Ctr
960212	T	204	724502000	2	1
960220	T	231	721900000	2	0
960221	T	231	721900000	2	0

Table 3.15 Sample output of *m1trt2.out* file

This comparison is made for the remaining LD codes 5, 6, 10, 11, and 12. The updated files are then assigned appropriate column headings (*Day*, *Cat*, *Demo*, *Diagcode*, *Ctr*).

3. Computing the MOE

The last step in computing the MOE is to perform the appropriate computations for each day using the updated files. Recall the assumptions for computing the man-days lost for patients receiving treatment and/or on limited duty:

- If on limited duty *only* , multiply the "Ctr" entry by 1 if a "1" appears (entry of "1" for man "out" that day; entry of "0" for those accounted for by another LD code).
- If receiving treatment *only* , multiply the "Ctr" entry by 0.5 if a "1" appears (entry of "1" implies not accounted for by another LD code or by the comparable "duty" file; entry of "0" otherwise).

The computations are performed by reading the updated files output by the aforementioned functions into another function to compute the day totals (i.e., function *m1daytotals* computes the day totals for Mission 1). This function sums, across all tables relating to the mission or mission segment (e.g., tables generated for LD codes 2, 5, 6, 10, 11, and 12 for Mission 1), the number of man-days lost each day due to individuals placed on limited duty and receiving treatment. Additional columns are created computing the man-hours lost per day due to placement on limited duty and receiving treatment. The last two columns created represent the total man-days lost and man-hours lost per day. The resulting file for Mission 1 (*m1totals*) is exported to Microsoft Excel and named *m1totals.xls*. All S-Plus commands used for computing the MOE for Mission 1 are given in Appendix D. A sample output of the file is given in Table 3.16. The complete file is given in Appendix E.

Date	D.Man-Days	D.Man-Hrs	T.Man-Days	T.Man-Hrs	Man-Days	Man-Hrs
960115	3	72	2.5	60	5.5	132
960116	4	96	2.5	60	6.5	156
960117	5	120	2	48	7	168

Table 3.16 Sample output of *m1totals.xls* file

4. Subsequent Computations

As will be seen in Chapter IV, the graphical results of man-days lost over time for each mission and mission segment show little variation in totals from mission(s) to mission segment(s). This is primarily due to the fact that of the 73 unique diagnosis codes, approximately 44 percent could potentially result in LD code 5 (no upper body) and approximately 38 percent could potentially result in LD code 6 (no lower body). Although only seven percent of those codes are considered to result in LD code 2 (no duty), those diagnosis codes making up the seven percent occur frequently in the database provided. As a result, these three LD codes have a significant impact on man-days lost.

In order to visualize differences based on specific activities, the MOE was modified somewhat and new computations were made. The modified MOE is defined as *activity dependent man-days lost over time due to MS injuries incurred by Navy SEALs*. Three specific activities in which SEALs were limited in performance were chosen: diving, swimming with fins, and running/walking under stressful conditions (corresponding to LD codes 4, 9, and 12, respectively).

This results in modification of the function which computes the day totals. The tables for LD categories 4, 9, and 12 are already existent in S-Plus. The corresponding "treatment" and "duty" tables were referred to as *ldrXt.out* and *ldrXd.out*, where X represents 4, 9, and 12. Therefore, in computing man-days lost over time due to Activity 4, only the *ldr4t.out* and *ldr4d.out* files have to be compared. The computations and creation of a table are performed by function *daytotalsact4* (see Table 3.17). An additional column, column five, is added to each file. A "1" is placed in every entry of column five in the *ldr4d.out* file (considered to be the "main" file). If the same record (fields one through four) appears in both files, a "0" is placed in column five of the *ldr4t.out* file to indicate it was accounted for by the *ldr4d.out* file; otherwise, a "1" is placed there to indicate it should be accounted for by the *ldr4t.out* file. Sample output of the file generated by function *daytotalsact4*, *a4totals* (saved as *a4totals.xls* after export to Microsoft Excel), which is used to plot man-days lost over time due to Activity 4, is given in Table 3.18. The output file generated for Activity 4 is given in Appendix F.

```
function()
{
        a4output <- matrix(0, nrow = 436, ncol = 7)
        a4output[, 1]  # now the first col is each of the 436 days in the file
        for(i in 1:nrow(a4output)) {
                day <- a4out  # first day is 951204
                tableda4 <- a4dupd[a4dupd[, 1] == day, ]
                dman.days <- sum(as.numeric(tableda4[, 5]))
                dman.hrs <- 24 * dman.days
                tableta4 <- a4tupd[a4tupd[, 1] == day, ]
                tman.days <- sum(as.numeric(tableta4[, 5]))
                tman.hrs <- 24 * tman.days
                a4output[i, 2] <- dman.days
                a4output[i, 3] <- dman.hrs
                a4output[i, 4] <- tman.days
                a4output[i, 5] <- tman.hrs
                a4output[i, 6] <- as.numeric(a4output[i, 2]) + 0.5 * as.numeric(a4output[i, 4])
                a4output[i, 7] <- as.numeric(a4output[i, 3]) + 0.5 * as.numeric(a4output[i, 5])
        }
        return(list(a4output = a4output))
}
```

Table 3.17 Function *daytotalsact4* to compute MOE as a function of "no diving".

Day	D.Man-Days	D.Man-Hrs	T.Man-Days	T.Man-Hrs	Man-Days	Man-Hrs
960212	0	0	4	96	2	48
960213	0	0	6	144	3	72
960214	0	0	7	168	3.5	84

Table 3.18 Sample output of *a4totals.xls*

All graphical and statistical results for Mission 1, Mission 25, Mission segment 1, Mission segment 3, and Activities 4, 9, and 12, are presented in Chapter IV.

IV. RESULTS

A. SAMPLE MISSIONS AND MISSION SEGMENTS

High frequency graphs were produced for Missions 1 and 25 and Mission Segments 1 and 3 showing man-days lost over time, dependent on each of the missions and segments. As mentioned in Chapter III, the results show little variation across this sample, primarily due to the impact of LD codes 2, 5, and 6. Before displaying results, it is important to note which LD codes affect each of the missions and mission segments in the sample. This information is given in Table 4.1.

Type	LD Codes Affecting Each Type
Mission 1	2, 5, 6, 10, 11, 12
Mission 25	2, 6, 7, 10, 11
Mission Segment 1	2, 5, 6, 8, 9
Mission Segment 3	2, 4, 5, 6, 8, 9

Table 4.1 LD Codes affecting each Mission/Segment in Sample

Graphical results are presented in Figures 4.1 through 4.4. Statistical results for the mean, variance and standard deviation of the number of man-days lost per day due to each of the missions and segments are given in Table 4.2.

Type	Mean # Man-days Lost Per Day	Variance	Standard Deviation
Mission 1	12.64	33.93	5.83
Mission 25	12.11	31.35	5.6
Mission Segment 1	11.49	29.6	5.44
Mission Segment 3	12.38	34.59	5.88

Table 4.2 Statistical Results - Missions and Mission Segments

As can be seen in Table 4.1, there is little difference in the mean number of men "out" per day for each of the missions and mission segments in the sample. Of more significance is the fact that, on average, approximately 12 men were out each day regardless of which mission or mission segment was considered. Keeping in mind that there are approximately only 900 SEALs attached to NSWG-TWO, 343 of which visited one of the clinics for MS injuries throughout the 13 month period, this number may be significant. The facts that many of the 900 SEALs attached at NSWG-TWO are on

deployment six months over the course of a year and that probably some of the data were lost may account for only 343 actually receiving treatment at NSWG-TWO Medical.

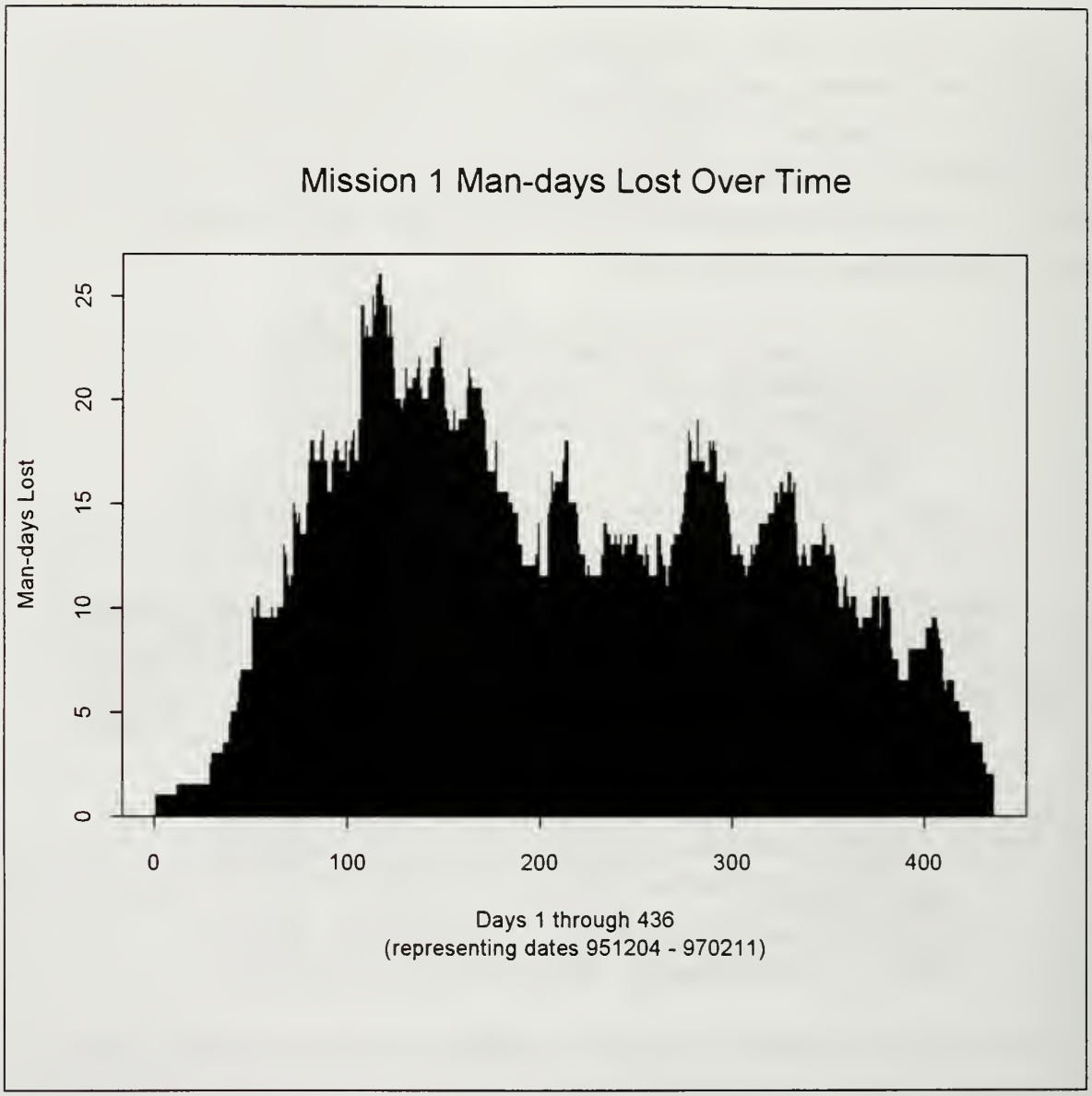

Figure 4.1 Mission 1 Man-days Lost Over Time

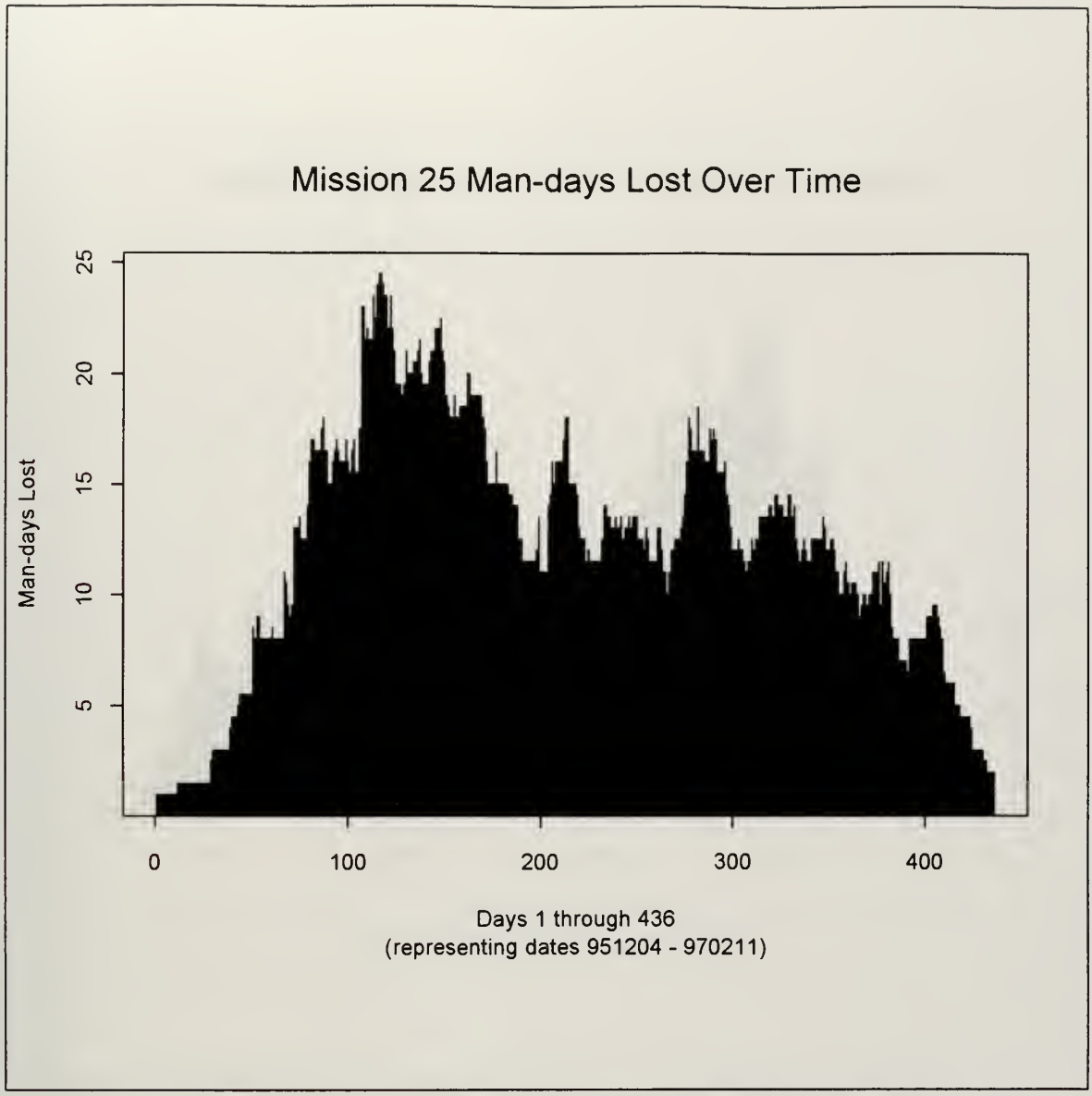

Figure 4.2 Mission 25 Man-days Lost Over Time

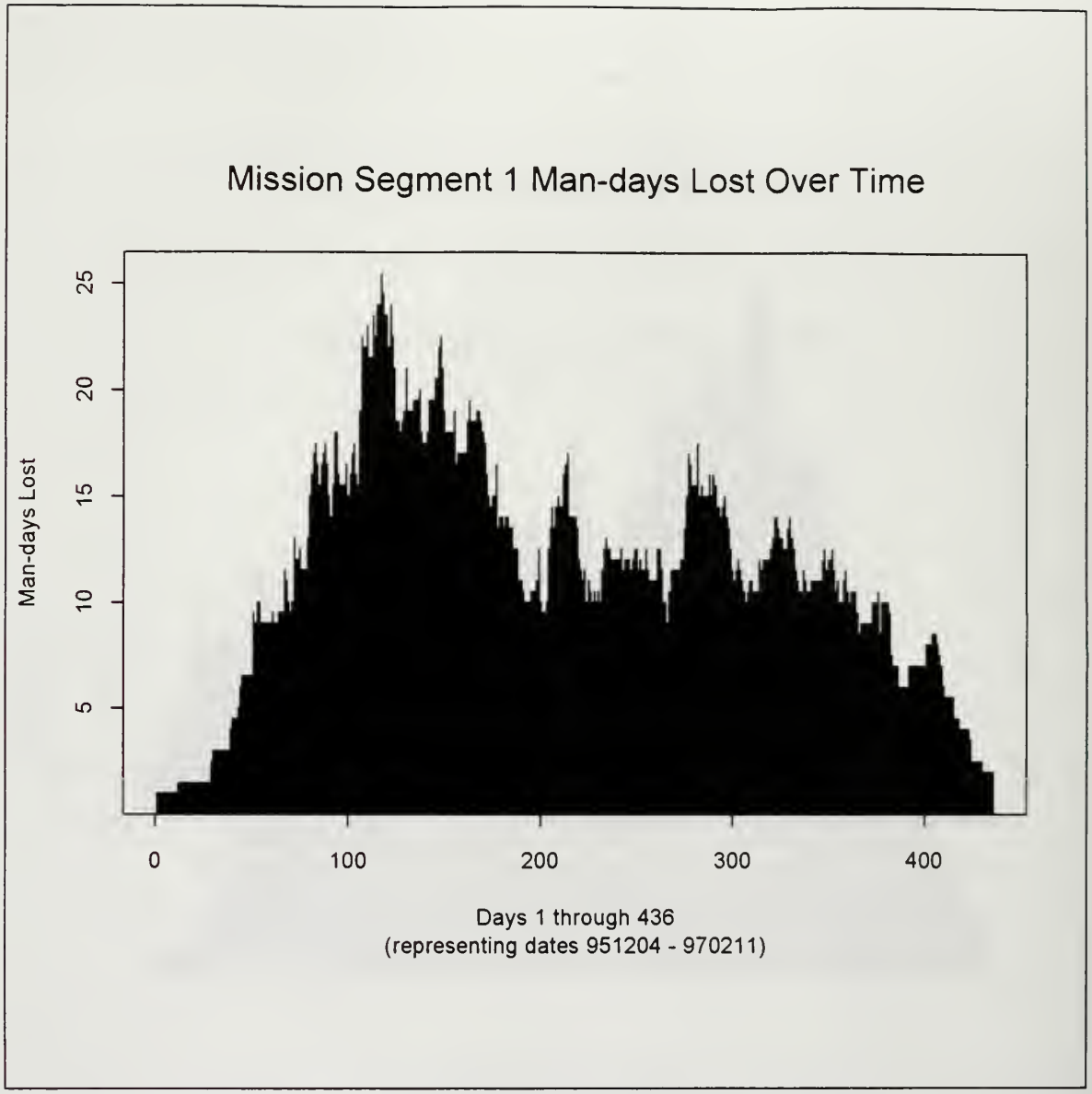

Figure 4.3 Mission Segment 1 Man-days Lost Over Time

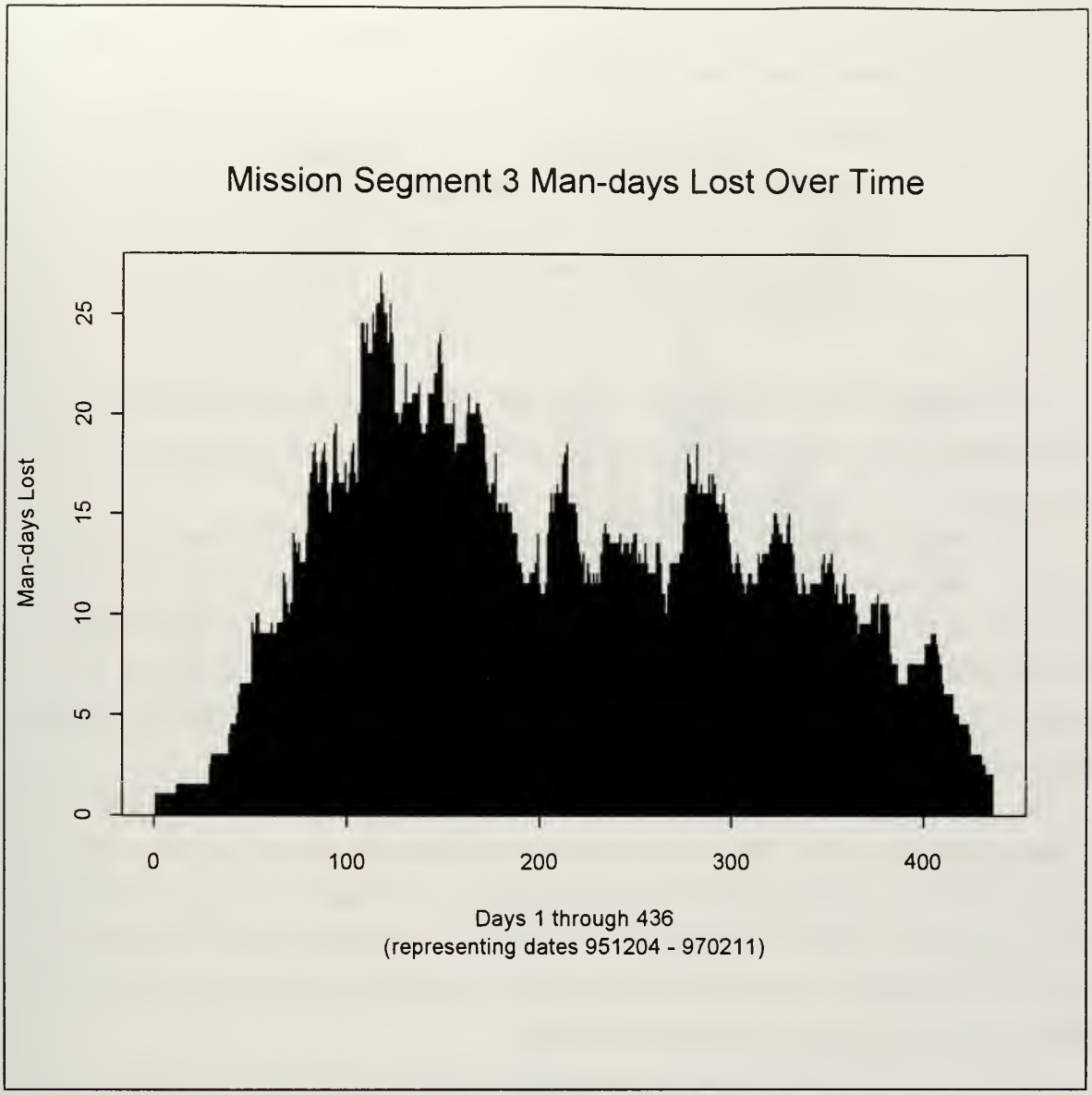

Figure 4.4 Mission Segment 3 Man-days Lost Over Time

B. SAMPLE ACTIVITIES

In order to more clearly see the variation from day to day as a result of particular activities utilized either during training or as an integral part of performing a specific mission or mission segment, the MOE was modified to be *activity dependent man-days lost over time*. Three different activities (diving, swimming with fins, and running/walking under stressful conditions), which are directly affected by LD codes 4, 9, and 12,

respectively, were chosen. Graphical results of each are displayed in Figures 4.5 through 4.7. The statistical results are given in Table 4.3.

Activity	Mean # Man-days Lost Per Day	Variance	Standard Deviation
4	3.08	3.22	1.79
9	4.62	4.94	2.22
12	5.47	10.33	3.21

Table 4.3 Statistical Results - Activities

It is evident, both graphically and statistically, that certain activities which SEALs perform regularly can lead to MS injuries and significantly impact the man-days lost over time as a result.

For example, consider Mission 1 which is directly affected by LD codes 2, 5, 6, 10, 11, and 12. As shown in Table 4.2, the mean number of man-days lost over time due to Mission 1 is 12.64. As indicated in Table 4.3, activity 12 (which is directly affected by LD code 12) resulted in 5.47 man-days lost over time. Of course, there would be some overlap by the other LD codes, but activity 12 alone makes up almost 44 percent of the average man-days lost over time for Mission 1.

A similar explanation also holds when comparing the results for Activity 9 to Mission Segment 1 results. The mean number of man-days lost due to Activity 9 alone, given in Table 4.3, is 4.62, while the mean number of man-days lost due to Mission Segment 1, given in Table 4.2 is 11.49. This implies that 40 percent of all man-days lost due to Mission Segment 1 can be attributed to not being able to perform (or perform to maximum potential) Activity 9, swimming with fins.

Finally, consider the comparison of results for Activity 4 and Mission Segment 3. As given in Table 4.3, 3.08 man-days lost are attributed to limited or no performance of Activity 4 and 12.38 man-days are lost due to Mission Segment 3 (Table 4.2). Because performance of Mission Segment 3 relies on being able to perform Activity 4, approximately 25 percent of the inability to perform Mission Segment 3 is a direct result of the inability to perform Activity 4, which is diving.

Again, it is important to note that these are estimates, because the last three comparisons do not take into account the other LD codes associated with each of the missions and mission segments in the sample.

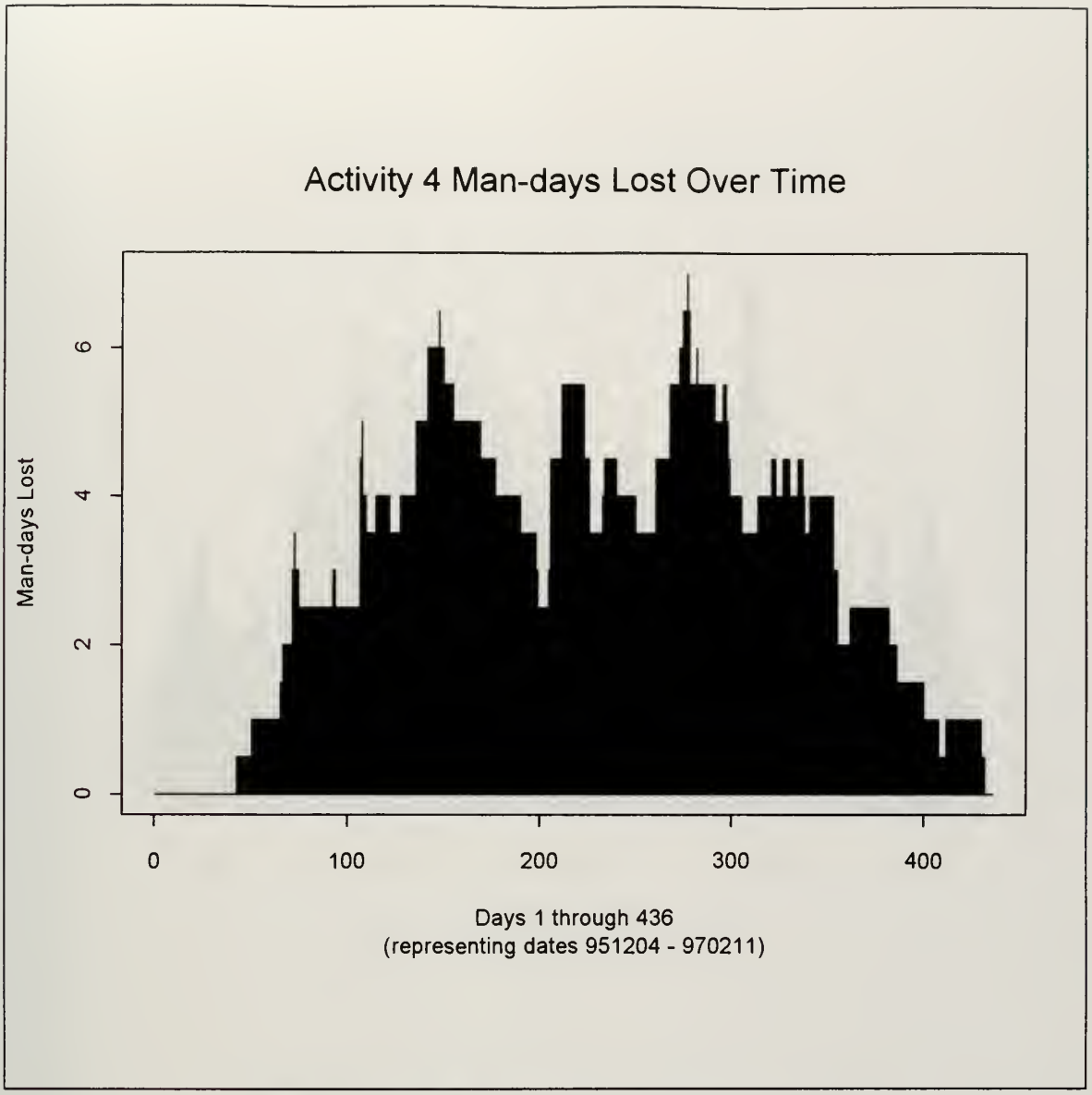

Figure 4.5 Activity 4 Man-days Lost Over Time

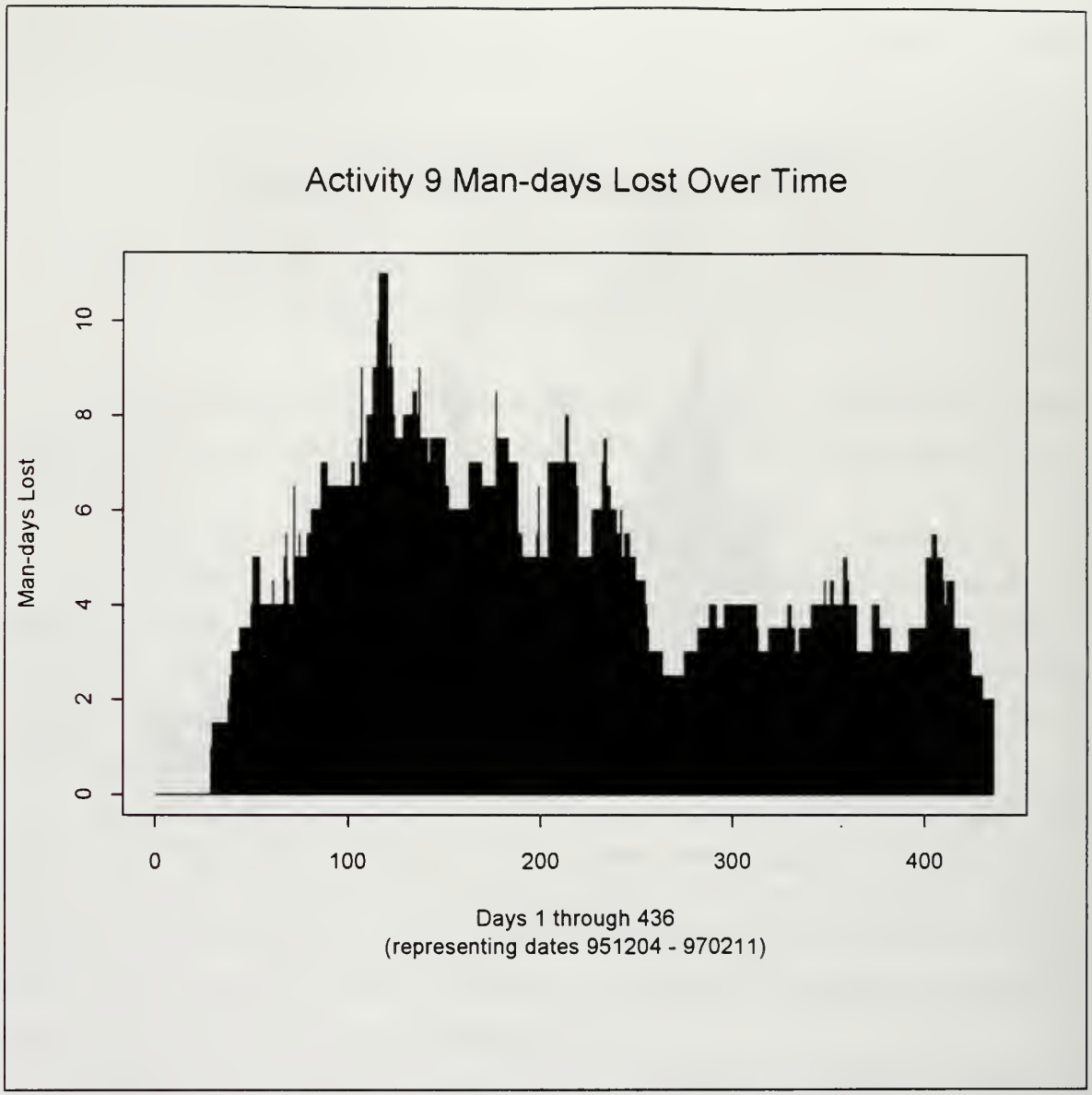

Figure 4.6 Activity 9 Man-days Lost Over Time

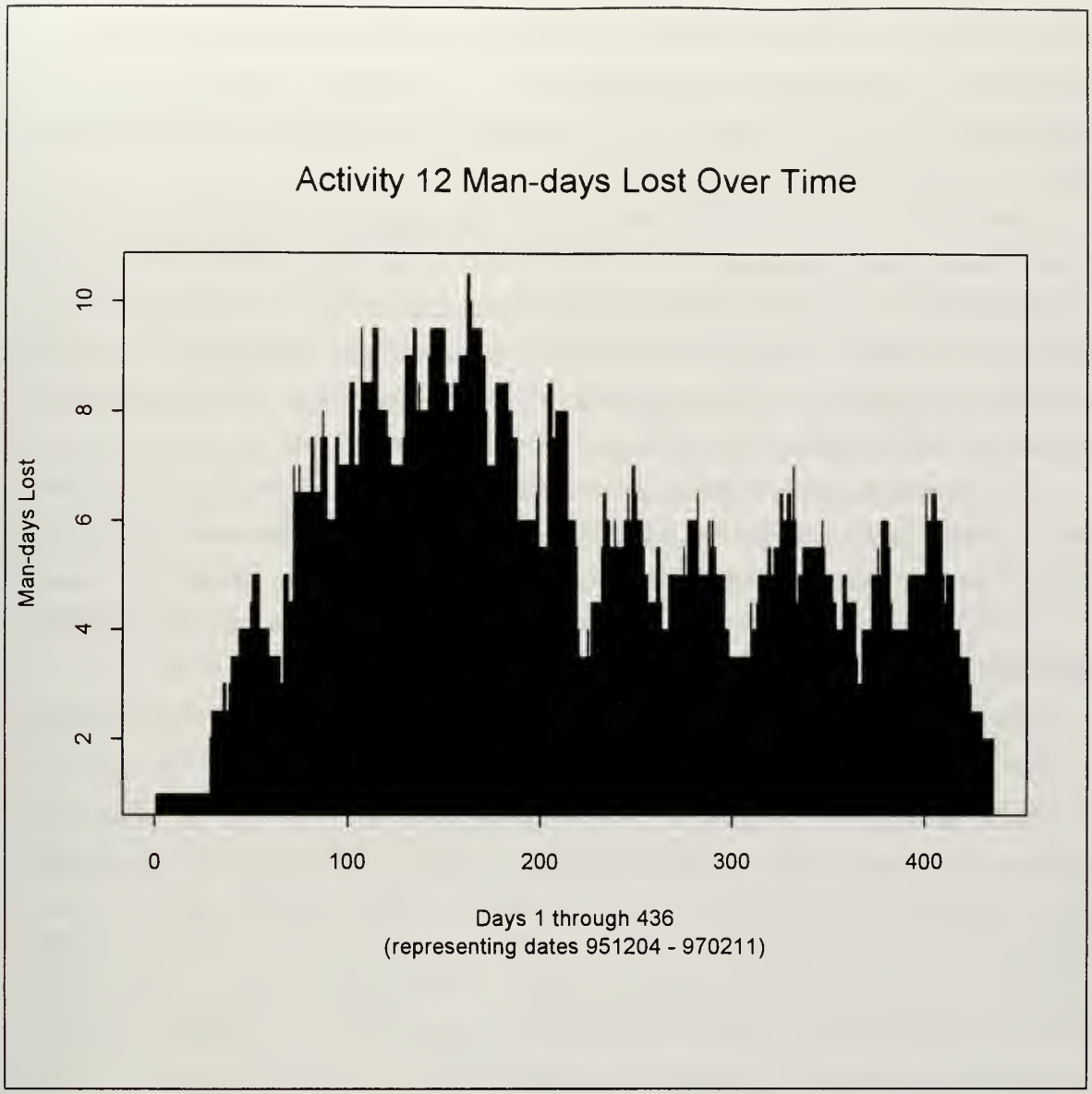

Figure 4.7 Activity 12 Man-days Lost Over Time

C. OVERVIEW OF GRAPHICAL RESULTS

1. Similarities in Overall Shape

As seen in Figures 4.1 through 4.7, a majority of the man-days lost over time occur between days 90 and 190 (corresponds roughly to the period of the middle of March through the end of June). The majority of man-days lost during this time period may be

because there were more SEALs present at the command (i.e., not on deployment) during that time; and as a result, appeared more frequently in the database during this time. There are also peaks which occur at various times throughout the course of the 13 month period, which would also indicate some type of seasonal variation.

There is little activity shown by any of the graphs at either the beginning or end of the time period of data collection. A possible reason for the small number of man-days lost per day in the beginning is the fact that the data collection started during the holiday season. Another reason may be that some data were lost and unrecovered. It was determined that the system of data collection, MADSYS, did "crash" on three separate occasions and that this occurred when the system was first put into use.

The man-days lost over time tapers off toward the end of the period of data collection and coincides with the fact there was little activity at the same time in 1996. It is unlikely that any data were lost during the last few months of data collection, because the person at NSWG-TWO who input the data was careful to save the information more regularly and also because the system had not "crashed" since April, 1996.

2. Differences in Overall Shape

Both Activities 4 (diving) and 9 (swimming with fins) are aquatic activities. However, there appears to be a peak in the graph of Activity 4 man-days lost over time (Figure 4.5) from day 260 through 305 (corresponding to mid June through August of 1996), which does not appear in the graph of Activity 9 man-days lost over time. This may be due to the fact that diving relies more on the use of the lower body, primarily the use of the hips and thighs. However, surface swimming involves greater reliance on the upper body, thus reducing the demands on the lower body.

Types of data collection necessary to more accurately determine man-days lost over time (due to missions, mission segments, or specific activities) are discussed in the next chapter. Also, areas of recommended future research are described.

V. RECOMMENDATIONS AND CONCLUSIONS

A. SUGGESTED DATABASE DESIGN

1. Data Items to be Collected

In addition to the data items collected by the software system MADSYS, other items should be collected. As mentioned in Chapter III, several data items were missing from the database used for analysis in this thesis. For example, the healing time estimate for a particular patient with a specific injury was not indicated. This information would be particularly useful if one had a computer program which would allow the user to specify a day, and output not only the current man-days lost, but also predict the number of man-days lost for some time in the future - based on the healing time estimate recorded by the reviewing physician.

Furthermore, there should be an indication of the patient's date of full recovery for a particular diagnosis. If a patient is still injured at the time of transfer to another location, separation from the service, or any other reason, this information should be recorded as well. It may also be useful to indicate when an individual is preparing for deployment in order to continue tracking and updating patient information.

In order to obtain a realistic report of man-days lost over time due to injury, the reviewing physician, together with the patient, should include which types of activities the individual either would not be able to perform at all or would result in a reduced performance capability. This information is especially important because certain injuries affect individuals in different ways as mentioned in Chapter III. One person's injury may result in his ability to perform a particular activity more effectively than another individual with the same injury. Activities considered essential that SEALs be able to perform should be listed and given a corresponding percentage of performance ability based on an agreement between the reviewing physician and the patient. Those activities given a "zero" percentage of performance ability would, obviously, refer to those in which the patient received a limited duty status by the physician. Those given a percentage other than zero would indicate that the individual would still be able to perform the activity, but not to his maximum capability. As time progresses, with the patient receiving treatment, this percentage would likely increase for a particular injury. Therefore, in order to

compute man-days lost *more accurately* for any given day, this information should be updated - *at least with every visit in which a patient receives treatment for that diagnosis.*

Therefore, rather than creating a mapping from diagnosis code to LD code regardless of the individual involved (as was the case in this thesis), this method of data collection would show how *each individual* is affected by *each injury*. This would allow for further analysis to determine if patients with the same diagnosis were affected in the same manner.

Another important consideration is the fact that many patients in the database were not given limited duty by the reviewing physician, but were receiving treatment frequently for long periods of time. Therefore, performing any activities which would directly utilize the muscles and joints injured would put the individual at risk. Determining the risk factors involved is another large project itself, but should be given consideration. Obviously, if an injured person continues to perform activities which directly affect the muscles and joints injured, this could prolong the injury and may even result in limited ability to heal properly. This could then lead to recurring problems and further complicate the matter. Because the SEALs are required to perform the most physically demanding types of activities, this population is even more at risk. If the Navy wants to keep those individuals who are so hard to acquire in the first place, and to keep them performing to their maximum potential, every precaution should be taken to minimize the risk of injury and to provide the best care in order that the affected areas heal properly and in a timely manner.

This suggestion further supports other work Dr. Prusaczyk had been conducting in collaboration with NSW medical personnel: to install facilities such as sports clinics, physical therapy clinics, and clinics housed with athletic trainers in NSW commands where such facilities do not exist. Not only will it be beneficial to the Navy in collecting the data items necessary to properly track man-days lost due to MS injuries incurred, but the Navy could also benefit by providing better care for its sailors whenever possible.

This type of data collection is not limited to Navy SEALs with MS injuries. The methodology can be implemented for all military personnel sustaining any type of injury which, as mentioned earlier, is currently lacking. To further stress the importance to the Department of Defense (DoD), adding the rank and associated pay scale for each patient in the database, along with the other parameters used in computing the MOE, would be beneficial. This would allow the users of the system to see on any particular day the actual cost to the DoD of personnel out with injuries that day.

2. Use of a Central Database

A centralized system would retrieve information on a daily basis from all Medical Facilities under its cognizance. The central location, of course, would be the controlling center. Each command under it would use the same system of data collection which would "be fed" into the central computer. In addition to the controlling center being able to determine aggregated operational information over all of its affiliate commands, the affiliate commands would also be able to assess their operational status at any time.

B. RECOMMENDATIONS FOR FUTURE RESEARCH

1. Software Design

Obviously, the design of the database as mentioned above constitutes a very important and practical topic for future research. In addition to actually writing a program to develop the database, there is a need to automatically update the MOE, perhaps based on a date input by the user. Furthermore, a program which would also forecast, based on the healing time estimates, the man-days lost for cost to DoD from a given date is needed. The entire program could encompass both aspects: generating the data on spreadsheets easily accessible by the user and generating a "cost to DoD" estimate either for the current time or some future time period.

With a system as described above, medical professionals would be equipped to determine the usefulness and effectiveness of their facilities in terms of providing health care for patients. Such information would aid in the ability of the facilities to determine areas where improvement is needed. The entire career of a SEAL could be tracked and researchers could determine if there are any injury patterns which individuals followed throughout the years. For example, if a patient encountered an Anterior Cruciate Ligament (ACL) tear (a particular type of knee injury) early in his career, the likelihood of experiencing similar injuries in the future could be established. Answering questions of this nature would greatly aid medical professionals in reassessing how to improve their role in the *individual* health care process.

2. Determining Distribution of MS Injuries

Once the proper data items were collected using the new database design, fitting the man-days lost over time to a particular distribution would allow researchers to determine if any seasonal variation exists and provide them with the proper statistical means for forecasting based on the particular distribution. Many other types of analyses could be conducted such as determining if there exists a relationship between the activities which resulted in particular injuries and the injuries themselves, or if individuals sustaining the same type of injury were affected in the same manner. If the data revealed both the physician's and individual's assessment of percentage of performance ability, analysis could be conducted to determine if there exists any correlation between the two.

The frequency of occurrence of injuries could provide guidance as to which injuries need to be more closely examined in terms of providing care. If researchers know which injuries are most likely to occur, specific action can be taken to reduce the occurrence of such injuries. For example, if the most frequent injuries are back-related injuries, then additional precautions may be taken at the training level to insure that proper exercise and strengthening of the back occur more frequently to minimize the occurrence of the injury. For those individuals in an operational status, the same techniques may be implemented to reduce occurrence of injury.

Finally, a ratio MOE could be computed for each affiliate command by dividing the man-days lost for each day by the total man-days available for any specified mission, mission segment or activity. This measure would provide a dynamic indicator of the operational readiness of the command to perform its assigned missions.

C. CONCLUSIONS

As stated earlier, MS injuries have been one of the major areas of research at NHRC, within the NSW community, and also within DoD. The creation of a central database and affiliate command databases for the tracking of MS injuries will provide the DoD with several important pieces of information. Such information includes how to improve each of its medical facilities based on an assessment of the effectiveness of each facility. The information retrieved from the database will also provide a means of incorporating better training and exercises to minimize risk to personnel. The information provided will also be useful as a contingency planning tool by recording the impact on

operational readiness, both in terms of man-days lost over time and estimation of cost to DoD, as a result of injury incurred by military personnel.

APPENDIX A. SAMPLE OUTPUT OF TREATMENT FILE CREATED IN PARADOX

NDXD	NDXV	NDXD	NDXT	TRTM	ENCDATE	CLINI	VISTY	ICDT	INJTY	INJME	ACTC	ACTS	SEX	RACE	BRANCH
102	3829	981	5402	9	11/5/96	1	1	1	3	1	4	2	1	1	1
102	3830	981	5405	5	11/7/96	4	2	1	3	1	4	2	1	1	1
102	3830	981	5404	6	11/7/96	4	2	1	3	1	4	2	1	1	1
102	3830	981	5403	9	11/7/96	4	2	1	3	1	4	2	1	1	1
105	105	105	101	9	1/3/96	1	1	3	3	2	6	12	1	1	1
105	110	105	105	6	1/5/96	4	2	3	3	2	6	12	1	1	1
105	110	105	103	9	1/5/96	4	2	3	3	2	6	12	1	1	1
105	110	105	104	1	1/5/96	4	2	3	3	2	6	12	1	1	1
105	299	264	244	1	1/11/96	4	2	3	1	2	6	12	1	1	1
105	299	264	243	6	1/11/96	4	2	3	1	2	6	12	1	1	1
105	557	264	325	9	1/12/96	4	2	3	1	2	6	12	1	1	1
105	557	264	325	9	3/19/96	3	2	3	1	2	6	12	1	1	1
105	574	105	326	9	2/13/96	1	2	3	3	2	6	12	1	1	1
105	574	105	326	9	2/13/96	4	2	3	3	2	6	12	1	1	1
105	575	105	327	9	2/14/96	4	2	3	3	2	6	12	1	1	1
105	575	105	327	9	2/14/96	4	2	3	3	2	6	12	1	1	1
105	576	105	328	9	2/16/96	4	2	3	3	2	6	12	1	1	1
105	576	105	328	9	2/16/96	4	2	3	3	2	6	12	1	1	1
105	586	105	329	9	3/11/96	4	2	3	3	2	6	12	1	1	1

DATEDEMO	ENCDATE.1	DIAGCODE	DIAGDESC	DIAGSPEC	DIAGDATE
1/2/96	11/5/96	726691000	ILIOTIBIAL BAND SYNDROME	RIGHT	11/2/96
1/2/96	11/5/96	726691000	ILIOTIBIAL BAND SYNDROME	RIGHT	11/2/96
1/2/96	11/5/96	726691000	ILIOTIBIAL BAND SYNDROME	RIGHT	11/2/96
1/2/96	11/5/96	726691000	ILIOTIBIAL BAND SYNDROME	RIGHT	11/2/96
1/2/96	1/3/96	844200000	SPRAIN - ANTERIOR CRUCIATE LIGAMENT	RIGHT	1/2/96
1/2/96	1/3/96	844200000	SPRAIN - ANTERIOR CRUCIATE LIGAMENT	RIGHT	1/2/96
1/2/96	1/3/96	844200000	SPRAIN - ANTERIOR CRUCIATE LIGAMENT	RIGHT	1/2/96
1/2/96	1/3/96	844200000	SPRAIN - ANTERIOR CRUCIATE LIGAMENT	RIGHT	1/2/96
1/2/96	01/23/96	V67000000	STATUS - POST SURGICAL PROCEDURE	RIGHT ACLR	2/22/96
1/2/96	01/23/96	V67000000	STATUS - POST SURGICAL PROCEDURE	RIGHT ACLR	2/22/96
1/2/96	01/23/96	V67000000	STATUS - POST SURGICAL PROCEDURE	RIGHT ACLR	2/22/96
1/2/96	01/23/96	V67000000	STATUS - POST SURGICAL PROCEDURE	RIGHT ACLR	2/22/96
1/2/96	1/3/96	844200000	SPRAIN - ANTERIOR CRUCIATE LIGAMENT	RIGHT	1/2/96
1/2/96	1/3/96	844200000	SPRAIN - ANTERIOR CRUCIATE LIGAMENT	RIGHT	1/2/96
1/2/96	1/3/96	844200000	SPRAIN - ANTERIOR CRUCIATE LIGAMENT	RIGHT	1/2/96
1/2/96	1/3/96	844200000	SPRAIN - ANTERIOR CRUCIATE LIGAMENT	RIGHT	1/2/96
1/2/96	1/3/96	844200000	SPRAIN - ANTERIOR CRUCIATE LIGAMENT	RIGHT	1/2/96
1/2/96	1/3/96	844200000	SPRAIN - ANTERIOR CRUCIATE LIGAMENT	RIGHT	1/2/96
1/2/96	1/3/96	844200000	SPRAIN - ANTERIOR CRUCIATE LIGAMENT	RIGHT	1/2/96

Note: The two tables combined by having the lower table directly to the right of the upper table represents the first 20 records of the treatment.xls file. Four columns (representing last name, first name, middle initial, and social security number) have been eliminated for privacy considerations. Some column headings are hidden in order to be able to fit the table on the page. The first encounter date (ENCDATE) is the date the patient visited a particular clinic for an injury. The second encounter date (ENCDATE.1) is the date of the first visit a patient had for a particular diagnosis and was not used in any of the analysis.

APPENDIX B. TRTDAYS AND LIMDUTY FILES CREATED IN S-PLUS

Trtdays File

NDXDEMO	NDXDIAG	DIAGCODE	First	FirstSrc	Last	LastSrc	Diff
102	981	726691000	961102	Diag	961107	Enc	0/0/5
112	112	71946A000	960108	Diag	960223	Enc	0/1/15
113	113	739300000	960108	Diag	960423	Enc	0/3/15
115	115	924200000	951204	Enc	960108	Diag	0/1/4
119	118	739300000	960109	Diag	960312	Enc	0/2/3
121	120	739200000	960109	Diag	960110	Enc	0/0/1
122	121	847100000	960110	Diag	961030	Enc	0/9/20
128	129	726691000	960111	Diag	960112	Enc	0/0/1
131	132	739300000	960111	Diag	960111	Diag	0/0/0
135	136	84080A000	960115	Diag	960925	Enc	0/8/10
138	140	726320000	960116	Diag	960311	Enc	0/1/25
143	146	739300000	960116	Diag	960122	Enc	0/0/6
146	150	739300000	960116	Diag	960125	Enc	0/0/9
155	160	844200000	960122	Diag	960131	Enc	0/0/9
156	821	726710000	960905	Diag	960924	Enc	0/0/19
157	164	847100000	960123	Diag	960123	Diag	0/0/0
158	301	719410000	960306	Diag	960306	Diag	0/0/0
162	169	84080A000	960123	Diag	960216	Enc	0/0/23
163	690	726710000	960729	Enc	960926	Enc	0/1/27
164	172	722400000	960123	Diag	960723	Enc	0/6/0
165	175	739300000	960124	Diag	960607	Enc	0/4/13
168	178	84200B000	960125	Diag	960125	Diag	0/0/0
177	187	726692000	960201	Diag	960202	Enc	0/0/1
181	191	726320000	960205	Diag	960213	Enc	0/0/8
182	192	739300000	960205	Diag	960206	Enc	0/0/1
184	194	726710000	960123	Enc	960206	Diag	0/0/13
186	197	726191000	960207	Diag	960618	Enc	0/4/11
191	202	84080B000	960208	Diag	960809	Enc	0/6/1
192	203	726310000	960208	Diag	960321	Enc	0/1/13
193	205	844100000	960209	Diag	960213	Enc	0/0/4
194	207	840000000	960202	Enc	960209	Diag	0/0/7
195	208	840000000	960209	Diag	960209	Diag	0/0/0
196	235	825290000	960213	Diag	960910	Enc	0/6/27
204	219	724502000	960212	Diag	960212	Diag	0/0/0
207	223	726191000	960213	Diag	960322	Enc	0/1/9
209	226	844200000	960110	Enc	960520	Enc	0/4/10
210	227	739300000	960213	Diag	960213	Diag	0/0/0
211	228	844200000	960213	Diag	960213	Diag	0/0/0
212	229	844200000	960102	Enc	960808	Enc	0/7/6

NDXDEMO	NDXDIAG	DIAGCODE	First	FirstSrc	Last	LastSrc	Diff
212	229	844200000	960102	Enc	960808	Enc	0/7/6
213	230	824800000	960213	Diag	960213	Diag	0/0/0
214	231	719410000	960213	Diag	970207	Enc	1/-1/24
217	234	715970000	960213	Diag	960402	Enc	0/1/19
218	236	84380B000	960213	Diag	960221	Enc	0/0/8
219	238	923100000	960214	Diag	960222	Enc	0/0/8
221	242	719410000	960214	Diag	960214	Diag	0/0/0
228	254	836000000	960216	Diag	960216	Diag	0/0/0
229	255	832000000	960220	Diag	960610	Enc	0/3/20
231	258	721900000	960220	Diag	960430	Enc	0/2/10
232	259	739300000	960220	Diag	960220	Diag	0/0/0
235	263	722000000	960221	Diag	961204	Enc	0/9/13
236	266	72664A000	960222	Diag	960223	Enc	0/0/1
237	267	818000000	960222	Diag	960223	Enc	0/0/1
238	268	726691000	960222	Diag	960301	Enc	0/0/9
243	274	728710000	960228	Diag	960228	Diag	0/0/0
251	834	844200000	960910	Diag	970121	Enc	0/4/11
252	287	8310A0000	951215	Enc	960521	Enc	0/5/6
254	290	724501000	960304	Diag	960304	Diag	0/0/0
255	291	726191000	960305	Diag	960305	Diag	0/0/0
264	303	845001B00	960306	Enc	960307	Diag	0/0/1
267	308	71946A000	960313	Diag	960313	Diag	0/0/0
271	653	729000000	960715	Diag	960715	Diag	0/0/0
272	314	848809000	960314	Enc	960315	Diag	0/0/1
273	315	845001B00	960306	Enc	960315	Diag	0/0/9
274	605	726191000	960625	Enc	960927	Enc	0/3/2
281	749	823900000	960820	Enc	960822	Diag	0/0/2
282	324	719410000	960319	Enc	961028	Enc	0/7/9
283	325	836000000	960319	Enc	961119	Enc	0/8/0
285	327	719410000	960319	Enc	960320	Diag	0/0/1
286	507	728710000	960513	Diag	960710	Enc	0/1/27
288	330	84080A000	960319	Enc	960919	Enc	0/6/0
289	331	84080B000	960320	Diag	960320	Diag	0/0/0
293	1027	715970000	961115	Diag	961126	Enc	0/0/11
294	337	724502000	960320	Diag	960417	Enc	0/0/27
295	339	818100000	960320	Diag	960522	Enc	0/2/2
298	344	728710000	960320	Diag	960522	Enc	0/2/2
307	355	724502000	960314	Enc	960325	Diag	0/0/11
312	501	728710000	960509	Diag	960522	Enc	0/0/13
313	363	840000000	960326	Diag	960814	Enc	0/4/18
314	364	728710000	960326	Diag	960403	Enc	0/0/7
315	365	726320000	960304	Enc	960402	Enc	0/0/28
326	377	739300000	960327	Diag	960327	Diag	0/0/0
327	378	726120000	960327	Diag	960403	Enc	0/0/6
328	380	727050000	960326	Enc	960404	Enc	0/0/8

NDXDEMO	NDXDIAG	DIAGCODE	First	FirstSrc	Last	LastSrc	Diff
329	381	840000000	960322	Enc	960418	Enc	0/0/26
330	382	726390000	960321	Enc	960330	Diag	0/0/9
334	387	813800000	960215	Enc	960502	Enc	0/2/17
336	390	823800000	960402	Diag	960404	Enc	0/0/2
338	392	84080A000	960327	Enc	960403	Enc	0/0/6
341	396	739300000	960401	Enc	960402	Diag	0/0/1
343	789	836000000	960903	Diag	961030	Enc	0/1/27
345	400	72340A000	960404	Diag	960422	Enc	0/0/18
353	413	729000000	960411	Enc	960417	Diag	0/0/6
356	417	726310000	960417	Enc	960422	Enc	0/0/5
357	420	726691000	960418	Diag	960418	Diag	0/0/0
360	425	924000000	960415	Enc	960418	Diag	0/0/3
362	427	844200000	960408	Enc	970121	Enc	0/9/13
363	428	825290000	960410	Enc	960503	Enc	0/0/23
364	792	724501000	960904	Diag	961001	Enc	0/0/27
366	431	71946A000	960403	Enc	960627	Enc	0/2/24
367	432	805800000	960419	Diag	960419	Diag	0/0/0
368	434	831000000	960418	Enc	960610	Enc	0/1/22
369	435	844200000	960212	Enc	961115	Enc	0/9/3
370	436	726100000	960409	Enc	960528	Enc	0/1/19
373	440	845001B00	960423	Diag	960423	Diag	0/0/0
378	445	726191000	960423	Enc	960520	Enc	0/0/27
379	971	728710000	961027	Diag	970107	Enc	0/2/10
381	448	844200000	960424	Diag	960603	Enc	0/1/9
387	795	723100000	960904	Diag	960927	Enc	0/0/23
390	461	726191000	960429	Diag	960429	Diag	0/0/0
395	467	739200000	960430	Diag	960430	Diag	0/0/0
400	840	832000000	960911	Diag	961127	Enc	0/2/16
402	880	840000000	960924	Diag	961011	Enc	0/0/17
407	484	72889D000	960506	Diag	960506	Diag	0/0/0
408	485	844100000	960506	Diag	960619	Enc	0/1/13
413	739	739200000	960819	Enc	960911	Enc	0/0/22
419	498	739200000	960509	Diag	970110	Enc	0/8/1
422	505	844000000	960513	Diag	960605	Enc	0/0/22
424	510	813900000	960514	Enc	960515	Diag	0/0/1
425	511	71946A000	960515	Diag	960515	Diag	0/0/0
433	528	739200000	960520	Diag	960529	Enc	0/0/9
439	539	739200000	960520	Enc	960521	Diag	0/0/1
445	553	844200000	960529	Enc	960531	Diag	0/0/2
449	559	844200000	960531	Diag	960813	Enc	0/2/12
452	720	726710000	960807	Enc	960813	Diag	0/0/6
457	571	739300000	960528	Enc	960531	Diag	0/0/3
462	581	739100000	960613	Enc	960617	Diag	0/0/4
466	592	726799000	960618	Enc	960619	Diag	0/0/1
470	597	836000000	960624	Diag	960805	Enc	0/1/11

NDXDEMO	NDXDIAG	DIAGCODE	First	FirstSrc	Last	LastSrc	Diff
477	606	726191000	960626	Diag	960905	Enc	0/2/9
490	625	845001B00	960628	Enc	960703	Enc	0/0/5
491	626	72889A000	960703	Diag	960703	Diag	0/0/0
499	931	739300000	961013	Diag	961112	Enc	0/0/29
507	646	739200000	960710	Diag	960710	Diag	0/0/0
513	659	845001A00	960717	Diag	960723	Enc	0/0/6
517	664	739300000	960722	Enc	960801	Enc	0/0/9
518	665	726650000	960723	Diag	960726	Enc	0/0/3
522	673	726710000	960723	Diag	960809	Enc	0/0/16
525	678	836000000	960726	Enc	960822	Enc	0/0/26
526	684	726191000	960723	Enc	960730	Diag	0/0/7
527	685	845001B00	960725	Enc	960812	Enc	0/0/17
530	692	836000000	960803	Diag	960919	Enc	0/1/16
533	696	840000000	960801	Enc	960815	Enc	0/0/14
534	697	722100000	960731	Enc	960806	Enc	0/0/5
541	707	924200000	960805	Enc	960815	Enc	0/0/10
549	719	845001B00	960807	Enc	960813	Diag	0/0/6
551	722	726100000	960724	Enc	960926	Enc	0/2/2
553	727	847100000	960814	Diag	961106	Enc	0/2/22
563	740	71946A000	960820	Enc	961121	Enc	0/3/1
571	757	71946A000	960823	Enc	960903	Enc	0/0/10
574	762	845001B00	960826	Enc	960910	Enc	0/0/14
576	772	726390000	960829	Diag	960919	Enc	0/0/20
580	781	726100000	960901	Diag	961105	Enc	0/2/4
581	782	724502000	960902	Diag	960923	Enc	0/0/21
584	786	726191000	960903	Diag	970106	Enc	0/4/3
587	793	726191000	960820	Enc	961001	Enc	0/1/11
588	794	724502000	960809	Enc	960913	Enc	0/1/4
589	796	8310A0000	960904	Diag	960924	Enc	0/0/20
595	814	724502000	960905	Diag	960910	Enc	0/0/5
596	816	84080A000	960905	Diag	960910	Enc	0/0/5
604	825	845001B00	960905	Enc	960916	Enc	0/0/11
606	830	726191000	960910	Diag	961223	Enc	0/3/13
607	833	722100000	960910	Diag	961101	Enc	0/1/21
608	835	723100000	960910	Diag	961004	Enc	0/0/24
614	850	845001B00	960916	Diag	961008	Enc	0/0/22
616	855	840000000	960916	Diag	961010	Enc	0/0/24
618	857	82380A000	960916	Diag	960924	Enc	0/0/8
625	866	845001B00	960918	Diag	960918	Diag	0/0/0
634	888	726191000	960924	Diag	961003	Enc	0/0/9
639	896	739200000	960929	Diag	961008	Enc	0/0/9
640	897	724502000	960419	Enc	970109	Enc	0/8/20
643	902	84212A000	961001	Diag	961031	Enc	0/0/30
649	911	818000000	961006	Diag	961029	Enc	0/0/23
654	920	845001B00	961011	Diag	970115	Enc	0/3/4

NDXDEMO	NDXDIAG	DIAGCODE	First	FirstSrc	Last	LastSrc	Diff
656	923	726100000	961012	Diag	961021	Enc	0/0/9
657	924	724502000	961012	Diag	961024	Enc	0/0/12
658	925	823800000	961012	Diag	961024	Enc	0/0/12
662	937	844200000	961017	Diag	961028	Enc	0/0/11
665	942	71946A000	961019	Diag	961030	Enc	0/0/11
667	944	726100000	961019	Diag	961104	Enc	0/0/15
668	945	724502000	961020	Diag	961030	Enc	0/0/10
672	952	72664A000	961020	Diag	961031	Enc	0/0/11
675	956	726191000	961025	Diag	961107	Enc	0/0/12
678	964	840000000	961027	Diag	961219	Enc	0/1/22
680	973	739300000	961027	Diag	961107	Enc	0/0/10
684	983	84080A000	961102	Diag	961219	Enc	0/1/17
685	987	923200000	961103	Diag	961126	Enc	0/0/23
686	988	72664A000	961104	Diag	961202	Enc	0/0/28
687	991	739300000	961107	Diag	961115	Enc	0/0/8
688	994	84190A000	961107	Diag	961115	Enc	0/0/8
689	995	844200000	961108	Diag	970130	Enc	0/2/22
697	1006	811000000	961108	Diag	970115	Enc	0/2/7
700	1016	845001B00	961114	Diag	961213	Enc	0/0/29
701	1017	724502000	961114	Diag	961121	Enc	0/0/7
730	1079	726100000	961129	Diag	970114	Enc	0/1/15
736	1099	924100000	961215	Diag	970109	Enc	0/0/24
738	1098	845001B00	961213	Enc	961220	Enc	0/0/7
739	1100	726710000	961215	Diag	961218	Enc	0/0/3
740	1102	923200000	961215	Diag	961223	Enc	0/0/8
747	1126	723400000	961229	Diag	970107	Enc	0/0/8
748	1127	82380A000	961229	Diag	970115	Enc	0/0/16
749	1128	836000000	961229	Diag	970129	Enc	0/1/0
752	1141	845001B00	970110	Diag	970124	Enc	0/0/14
753	1143	723100000	970110	Diag	970117	Enc	0/0/7
754	1144	724502000	970108	Enc	970130	Enc	0/0/22
762	1171	836000000	970107	Enc	970112	Diag	0/0/5
763	1172	723100000	970108	Enc	970113	Enc	0/0/5
766	1177	844200000	970110	Enc	970116	Enc	0/0/6
772	1188	71946A000	970118	Diag	970205	Enc	0/0/17
773	1190	726000000	970118	Diag	970205	Enc	0/0/17

Limduty File

NDXDEMO	NDXVIST	NDXDIAG	NDXDUTY	DUTYSTAT	TIME	START	STOP	DIAGCODE
115	118	115	112	6	37	951204	960109	924200000
122	126	121	119	10	11	960111	960121	847100000
128	133	129	124	7	15	960112	960126	726691000
138	143	140	133	5	29	960117	960214	726320000
158	164	165	154	5	22	960123	960213	72889A000
168	180	178	166	5	15	960125	960208	84200B000
193	221	205	191	6	23	960208	960301	844100000
212	250	229	208	5	26	960116	960210	844200000
213	252	230	209	6	36	960213	960319	824800000
215	254	232	211	2	79	960101	960319	822000000
219	262	238	214	5	15	960214	960228	923100000
229	284	255	230	5	0	960220	960219	832000000
231	289	258	234	2	3	960220	960222	721900000
235	297	263	239	3	21	960221	960312	722000000
235	297	263	240	6	21	960221	960312	722000000
237	301	267	243	5	12	960223	960305	818000000
113	309	113	247	7	30	960223	960323	739300000
245	319	276	253	6	36	960227	960402	825290000
254	343	290	268	6	8	960304	960311	724501000
267	362	307	278	7	15	960313	960327	836100000
231	443	258	281	6	15	960315	960329	721900000
273	449	315	285	6	10	960306	960315	845001B00
213	553	230	286	7	93	960319	960619	824800000
135	554	136	287	5	93	960319	960619	84080A000
144	598	147	289	2	21	960319	960408	72889D000
292	628	335	292	7	15	960318	960401	726691000
294	630	337	293	2	3	960318	960320	724502000
294	631	337	294	6	7	960319	960325	724502000
298	641	344	296	7	8	960320	960327	728710000
313	678	363	305	5	8	960325	960401	840000000
314	680	364	306	7	8	960325	960401	728710000
327	702	378	316	8	6	960327	960401	726120000
328	705	380	317	5	17	960313	960329	727050000
329	707	381	318	5	14	960322	960404	840000000
329	712	381	319	3	9	960328	960405	840000000
336	898	390	322	7	43	960402	960514	823800000
343	906	398	324	5	9	960328	960405	922000000
344	951	399	325	10	16	960403	960418	84200B000
345	953	400	325	5	16	960403	960418	72340A000
294	1019	337	340	3	13	960417	960429	724502000
357	1025	420	342	6	14	960418	960501	726691000
184	1050	194	345	6	6	960411	960416	726710000
362	1108	427	348	6	14	960403	960416	844200000
368	1155	434	351	3	15	960417	960501	831000000
369	1158	435	352	7	152	960208	960708	844200000
373	1208	440	355	7	31	960423	960523	845001B00
378	1245	445	360	5	14	960423	960506	726191000
385	1282	454	364	5	32	960311	960411	722000000
385	1283	454	366	5	18	960426	960513	722000000

NDXDEMO	NDXVIST	NDXDIAG	NDXDUTY	DUTYSTAT	TIME	START	STOP	DIAGCODE
422	1562	505	390	6	15	960513	960527	844000000
423	1580	508	392	5	15	960514	960528	727050000
424	1583	510	394	5	15	960514	960528	813900000
445	1829	553	419	6	12	960528	960608	844200000
449	1839	559	425	6	12	960528	960608	844200000
464	1888	586	443	6	16	960619	960704	836000000
469	2013	596	450	7	3	960624	960626	84480A000
470	2014	597	451	3	16	960624	960709	836000000
470	2014	597	452	9	16	960624	960709	836000000
472	2016	599	453	11	16	960619	960704	723400000
480	2033	610	463	5	18	960626	960713	726191000
489	2096	624	473	5	15	960702	960716	726191000
490	2097	625	474	5	7	960628	960704	845001B00
491	2116	626	475	5	30	960703	960801	72889A000
513	2248	659	505	7	8	960717	960724	845001A00
525	2285	678	524	6	8	960722	960729	836000000
557	2588	731	569	6	8	960814	960821	836100000
559	2611	733	571	5	11	960814	960824	922000000
572	2725	760	598	5	11	960827	960906	84080A000
574	2738	762	600	6	16	960826	960910	845001B00
587	2834	793	632	5	93	960820	961120	726191000
641	3369	898	739	7	11	961008	961018	82380A000
643	3396	902	744	5	23	961010	961101	84212A000
647	3459	909	750	5	7	961016	961022	727100000
660	3569	930	768	6	9	961023	961031	71946A000
666	3631	943	780	7	16	961030	961114	844201000
683	3729	980	816	5	15	961108	961122	831000000
697	3939	1006	843	5	26	961118	961213	811000000
685	3983	987	851	5	4	961122	961125	923200000
705	4070	1026	863	6	7	961125	961201	836000000
671	4081	951	870	6	18	961126	961213	724502000
716	4201	1050	889	7	15	961205	961219	845001B00
731	4240	1080	922	7	98	961210	970317	844200000
765	4701	1176	1018	6	196	970107	970721	924000000

APPENDIX C. FILE REFLECTING MAPPING OF DIAGNOSIS CODES TO LD CODES

Unqcode.txt File

DIAGCODE	LD2	LD3	LD4	LD5	LD6	LD7	LD8	LD9	LD10	LD11	LD12
729000000	0	1	0	0	1	1	0	0	0	0	1
715970000	0	1	0	0	0	1	0	1	0	0	1
719410000	0	0	1	0	0	0	1	1	1	0	0
71946A000	0	1	0	0	0	0	0	0	0	0	1
721900000	1	0	0	0	1	0	0	0	0	0	0
722000000	0	1	0	1	1	0	0	0	0	0	0
722100000	0	1	0	0	1	0	0	0	1	0	0
722400000	0	0	0	1	0	0	0	0	1	0	0
723100000	0	0	0	1	0	0	0	0	1	0	0
723400000	0	0	0	1	0	0	0	0	1	0	0
72340A000	0	0	0	1	0	0	1	1	1	0	0
724501000	0	0	0	0	1	0	0	0	0	0	0
724502000	1	1	0	1	1	0	0	0	0	0	0
726000000	0	0	1	1	0	0	1	1	1	1	0
726100000	0	0	1	1	0	0	0	0	1	1	0
726120000	0	0	0	1	0	0	1	1	1	0	0
726191000	0	0	1	1	0	0	0	0	1	0	0
726310000	0	0	0	0	0	0	0	0	1	0	0
726320000	0	0	0	1	0	0	0	0	0	0	0
726390000	0	0	0	0	0	0	0	0	1	0	0
72664A000	0	0	0	0	1	1	0	0	0	0	1
726650000	0	0	0	0	1	1	1	1	0	0	1
726691000	0	0	0	0	1	1	0	1	0	0	1
726692000	0	0	0	1	0	0	1	1	1	0	0
726710000	0	0	0	0	1	1	0	0	0	0	1
726799000	0	0	0	0	0	1	0	1	0	0	1
727050000	0	0	0	1	0	0	0	0	0	0	0
727100000	0	0	0	0	0	0	0	0	0	0	0
728710000	0	0	0	0	1	1	0	0	0	0	1
72889A000	0	0	1	1	0	0	1	1	1	1	0
72889D000	1	0	0	0	0	0	0	0	0	0	0
739100000	0	0	0	0	0	0	0	0	0	0	0
739200000	0	0	0	0	0	0	0	0	0	0	0
739300000	0	0	0	0	0	0	0	0	0	0	0
805800000	1	0	0	1	0	0	0	0	0	0	0
811000000	0	0	0	1	0	0	1	1	1	0	0
813800000	0	0	0	1	0	0	0	0	1	0	0
813900000	0	0	0	1	0	0	1	1	1	0	0
818000000	0	0	0	1	0	0	0	0	1	0	0

DIAGCODE	LD2	LD3	LD4	LD5	LD6	LD7	LD8	LD9	LD10	LD11	LD12
818100000	0	0	0	1	0	0	0	0	1	0	0
822000000	0	0	0	0	1	1	1	1	0	0	1
823800000	0	0	0	0	1	1	0	0	0	0	1
82380A000	0	0	0	0	0	1	0	0	0	0	1
823900000	0	0	0	0	1	1	0	0	0	0	1
824800000	0	0	0	0	1	1	1	1	0	0	1
825290000	0	0	0	0	1	0	0	1	0	0	1
831000000	0	1	1	1	0	0	0	0	1	0	0
8310A0000	0	0	1	1	0	0	0	0	1	0	0
832000000	0	0	0	1	0	0	1	1	1	0	0
836000000	0	1	0	0	1	0	0	1	0	0	1
836100000	0	1	0	0	1	1	0	0	0	0	1
840000000	0	0	1	1	0	0	1	1	1	0	0
84080A000	0	0	1	1	0	0	0	0	1	0	0
84080B000	0	0	1	0	0	0	0	0	1	0	0
84190A000	0	0	0	1	0	0	0	0	1	0	0
84200B000	0	0	0	1	0	0	0	0	1	0	0
84212A000	0	0	0	1	0	0	0	0	1	0	0
84380B000	0	0	0	0	1	0	0	0	0	1	0
844000000	0	0	0	0	1	0	0	0	0	0	1
844100000	0	1	0	0	1	1	0	0	0	0	1
844200000	0	0	0	0	1	1	0	1	0	0	1
844201000	0	0	0	0	0	1	0	0	0	0	1
84480A000	0	0	0	0	1	1	0	0	0	0	1
845001A00	0	0	0	0	0	1	0	1	0	0	1
845001B00	0	1	0	0	1	1	0	0	0	0	1
847100000	0	0	0	1	0	0	0	0	1	1	0
848809000	0	0	0	0	1	1	1	1	0	0	1
922000000	0	0	0	1	0	0	0	0	1	1	0
923100000	0	0	0	1	0	0	0	0	1	0	0
923200000	0	0	0	1	0	0	0	0	1	0	0
924000000	0	0	0	0	1	1	0	1	0	0	1
924100000	1	0	0	0	1	1	0	0	0	0	1
924200000	0	0	0	0	1	1	0	0	0	0	1

APPENDIX D. S-PLUS COMMANDS AND FUNCTIONS FOR COMPUTING MISSION ONE MOE

Mission 1:

```
>#  Requires activities affected by LD codes 2, 5, 6, 10, 11, 12
>#  Will makes pairwise comparisons for all treatment file information
>#   which are (2,5), (2,6), (2,10), (2,11), (2,12), (5,6), (5,10), (5,11), (5,12),
>#  (6,10), (6,11), (6,12), (10,11), (10,12), (11,12)
>#  This will require 15 steps for comparison of treatment file information
>#  Function names are m1t1, m1t2, ..., m1t15 referring to Mission 1 Treatment Step 1,... Mission 1
>#  Treatment Step 15

>#  Creating the Tables ldrX.out, where X represents 2,5,6,10,11,12
>  #  First look at the function which will create a table for LD Code 2;
>  #  Similar functions are used for creating tables for the other LD Codes
> ldtable2
function(rowcodes, unqcode)
{
# rowcodes here is the dutyntrt file
# unqcode is the unqcode file
        t2.ctr <- 1
        table2 <- matrix(" ", nrow = 2500, ncol = 4)
        rowcodes.col <- ncol(rowcodes)
        for(i in 1:nrow(rowcodes)) {
                cat("Now on row ", i)
                j.seq <- seq(4, rowcodes.col, by = 3)
                js <- rowcodes[i, j.seq]
                js <- js[js != "99999" & js != "    99999"]
                j.seq <- seq(4, by = 3, length = length(js))
                samprows <- unqcode[as.logical(match(unqcode[, 1], js, 0)),  , drop = F]
                which.are.2 <- samprows[samprows[, 2] == "1", 1]
                if(length(which.are.2) != 0) {
                        cat("...found!\n")
                        j.seq <- j.seq[as.logical(match(js, which.are.2, 0))]
                        right <- cbind(i, c(rbind(1, j.seq - 2, j.seq - 1, j.seq)))
                        n <- length(j.seq)
                        left <- cbind(rep(t2.ctr:(t2.ctr + n - 1), rep(4, n)), rep(1:4, n))
                        table2[left] <- rowcodes[right]
                        t2.ctr <- t2.ctr + n
                }
                else cat("...nothing there\n")
        }
        return(list(table2 = table2))
}
> ldr2out_ldtable2(dutyntrt,unqcode) # passes in the files dutyntrt and unqcode
>ldr2.out_ldr2out$table2              # extracts the table 2 created by the function, stores it as ldr2.out
>ldr2t.out_ldr2.out[ldr2.out[,2]=="T",]  # extracts only the treatment records from the table
```

```
>#  The same commands are applied to each of the functions which are used to create tables
>#  for the other LD Codes. The result is 5 files named ldr5t.out, ldr6t.out, ldr10t.out,
>#  ldr11t.out, ldr12t.out

>#  Now, the first level of pairwise comparisons , (2,5), (2,6), (2,10), (2,11), (2,12):
>#  First, to compare (2,5)
>#  Using the function m1t1
>m1t1
function(ldr2t.out, ldr5t.out)
{
#
# mission 1 t1: deluxe version
#
        vec.2 <- apply(ldr2t.out, 1, paste, collapse = "")
        vec.5 <- apply(ldr5t.out, 1, paste, collapse = "")
        matchers <- match(vec.5, vec.2)
        ldr2t <- cbind(ldr2t.out, rep("2", nrow(ldr2t.out)))
        ldr5t <- cbind(ldr5t.out, rep("5", nrow(ldr5t.out)))
        new.col <- ncol(ldr5t)
        ldr5t[!is.na(matchers), new.col] <- "2"
        return(list(ldr2t = ldr2t, ldr5t = ldr5t))
}
>m1.out_m1t1(ldr2t.out,ldr5t.out)
>m1out2t_m1.out$ldr2t            #  stores the resulting ldr2t table in m1out2t
>m1out5t_m1.out$ldr5t            #  stores the resulting ldr5t table in m1out5t
>m2.out_m1t2(ldr2t.out,ldr6t.out)
>m2out6t_m2.out$ldr6t            #  stores the resulting ldr6t table in m2out6t
> #  no need to keep outputting the ldr2t table because it will not change
>m3.out_m1t3(ldr2t.out,ldr10t.out)
>m3out10t_m3.out$ldr10t
>m4.out_m1t4(ldr2t.out,ldr11t.out)
>m4out11t_m4.out$ldr11t
>m5.out_m1t5(ldr2t.out,ldr12t.out)
>m5out12t_m5.out$ldr12t

>#  Second level pairwise comparisons: (5,6), (5,10), (5,11), (5,12)
>#  Using the updated tables m1out5t, m2out6t, m3out10t, m4out11t, m5out12t
> m1t6
function(m1out5t, m2out6t)
{
#
# mission 1 t6: deluxe version
# This function receives the first updated version of
# the file ldr5t.out (m1out5t) and uses it to compare to
# most recent version of ldr6t.out (m2out6t)
# Can only use apply on cols 1 thru 4 of m1out5t and m2out6t
# Places a "5" in col 5 of m2out6t if that row of m2out6t
# exactly matches a row in m1out5t
        vec.5 <- apply(m1out5t[, c(1:4)], 1, paste, collapse = "")
        vec.6 <- apply(m2out6t[, c(1:4)], 1, paste, collapse = "")
```

```
        matchers <- match(vec.6, vec.5)
        ldr6t <- m2out6t
        new.col <- ncol(ldr6t)
        not2s <- ldr6t[!is.na(matchers),new.col] != 2
        # take the entries that haven't already been accounted
        # for in ld2 file and assign them a "5" in col 5
        ldr6t[(!is.na(matchers)) & (not2s), new.col] <- "5"
        return(list(ldr6t = ldr6t))
}
>m6.out_m1t6(m1out5t,m2out6t)
>m6out6t_m6.out$ldr6t
>m7.out_m1t7(m1out5t,m3out10t)
>m7out10t_m7.out$ldr10t
>m8.out_m1t8(m1out5t,m4out11t)
>m8out11t_m8.out$ldr11t
>m9.out_m1t9(m1out5t,m5out12t)

>#  Third level pairwise comparisons: (6,10), (6,11), (6,12)
>#  Using updated tables m6out6t, m7out10t, m8out11t, m9out12t
> m1t10
function(m6out6t, m7out10t)
{
#
# mission 1 t10: deluxe version
# This function receives the 2nd updated version of
# the file ldr6t.out (m6out6t) and uses it to compare to
# most recent version of ldr10t.out (m7out10t)
# Can only use apply on cols 1 thru 4 of m6out6t and m7out10t
# Places a "6" in col 5 of m7out10t if that row of m7out10t
# exactly matches a row in m6out6t
        vec.6 <- apply(m6out6t[, c(1:4)], 1, paste, collapse = "")
        vec.10 <- apply(m7out10t[, c(1:4)], 1, paste, collapse = "")
        matchers <- match(vec.10, vec.6)
        ldr10t <- m7out10t
        new.col <- ncol(ldr10t)
        not2s <- ldr10t[!is.na(matchers),new.col] != 2
        not5s <- ldr10t[!is.na(matchers),new.col] != 5
        # take the entries that have already been accounted for by
        # ld2 or ld5 file and assign them a "6" in col 5
        ldr10t[(!is.na(matchers)) & (not2s) & (not5s), new.col] <- "6"
        return(list(ldr10t = ldr10t))
}
>m10.out_m1t10(m6out6t,m7out10t)
>m10out10t_m10.out$ldr10t
>m11.out_m1t11(m6out6t,m8out11t)
>m11out11t_m11.out$ldr11t
>m12.out_m1t12(m6out6t,m9out12t)
>m12out12t_m12.out$ldr12t

# Fourth level pairwise comparisons: (10,11), (11,12)
```

```
# Using updated tables m10out10t, m11out11t, m12out12t
> m1t13
function(m10out10t, m11out11t)
{
#
# mission 1 t13: deluxe version
# This function receives the 3rd updated version of
# the file ldr10t.out (m10out10t) and uses it to compare to
# most recent version of ldr11t.out (m11out11t)
# Can only use apply on cols 1 thru 4 of m10out10t and m11out11t
# Places a "10" in col 5 of m11out11t if that row of m11out11t
# exactly matches a row in m10out10t
        vec.10 <- apply(m10out10t[, c(1:4)], 1, paste, collapse = "")
        vec.11 <- apply(m11out11t[, c(1:4)], 1, paste, collapse = "")
        matchers <- match(vec.11, vec.10)
        ldr11t <- m11out11t
        new.col <- ncol(ldr11t)
        not2s <- ldr11t[!is.na(matchers),new.col] != 2
        not5s <- ldr11t[!is.na(matchers),new.col] != 5
        not6s <- ldr11t[!is.na(matchers),new.col] != 6
        # take entries that haven't already been accounted for
        # by ld2, ld5 or ld6 files and assign them a "10" in col 5
        ldr11t[(!is.na(matchers)) & (not2s) & (not5s) & (not6s), new.col] <- "10"
        return(list(ldr11t = ldr11t))
}
>m13.out_m1t13(m10out10t,m11out11t)
>m13out11t_m13.out$ldr11t
>m14.out_m1t14(m10out10t,m12out12t)
>m14out12t_m14.out$ldr12t

# Last comparison: (11,12)
# Using updated tables m13out11t, m14out12t
>  m1t15
function(m13out11t, m14out12t)
{
#
# mission 1 t15: deluxe version
# This function receives the 4th updated version of
# the file ldr11t.out (m13out11t) and uses it to compare to
# most recent version of ldr12t.out (m14out12t)
# Can only use apply on cols 1 thru 4 of m13out11t and m14out12t
# Places a "11" in col 5 of m14out12t if that row of m14out12t
# exactly matches a row in m13out11t
        vec.11 <- apply(m13out11t[, c(1:4)], 1, paste, collapse = "")
        vec.12 <- apply(m14out12t[, c(1:4)], 1, paste, collapse = "")
        matchers <- match(vec.12, vec.11)
        ldr12t <- m14out12t
        new.col <- ncol(ldr12t)
        not2s <- ldr12t[!is.na(matchers),new.col] != 2
        not5s <- ldr12t[!is.na(matchers),new.col] != 5
```

```
        not6s <- ldr12t[!is.na(matchers),new.col] != 6
        not10s <- ldr12t[!is.na(matchers),new.col] != 10
        # take entries that haven't already been accounted for
        # by ld2, ld5, ld6 or ld10  files and assign them an "11" in col 5
        ldr12t[!is.na(matchers), new.col] <- "11"
        return(list(ldr12t = ldr12t))
}
>m15.out_m1t15(m13out11t,m14out12t)
>m15out12t_m15.out$ldr12t
```

># Updated "treatment" tables are m1out2t, m1out5t, m6out6t, m10out10t, m13out11t, m15out12t

># Use similar functions for comparing all the ldrXd.out files
># Results are the updated "duty" tables m1dout2d, m1dout5d, m6dout6d, m10dout10d,
># m13dout11d, m15dout12d

># Now compare the updated "treatment" and "duty" tables
># Function m1d2t2 compares m1out2t and m1dout2d:

```
> m1d2t2
function(m1out2t, m1dout2d)
{
# mission1: compare trmt ld2 to duty ld2
# to check for equal entries
# If the same person with the same diagnosis for
# a given day is put on limited duty and is seeking
# treatment, man-hrs lost will only be accounted for
# in the limited duty file; if he's only being treated
# man-hrs lost will be accounted for in the treatment
# file
        vec.2d <- apply(m1dout2d[, c(1, 3, 4)], 1, paste, collapse = "")
        vec.2t <- apply(m1out2t[, c(1, 3, 4)], 1, paste, collapse = "")
        matchers <- match(vec.2t, vec.2d)
        ldr2d <- cbind(m1dout2d, rep("1", nrow(m1dout2d)))
        ldr2t <- cbind(m1out2t, rep("T", nrow(m1out2t)))
        # if it does match, put a 0 where the T is in the trmt file
        new.col <- ncol(ldr2t)
        ldr2t[!is.na(matchers), new.col] <- "0"
        # if it does not match, put a 1 where the T is in the trmt file
        ldr2t[is.na(matchers), new.col] <- "1"
        return(list(ldr2d = ldr2d, ldr2t = ldr2t))
}
>m1d2t2.out_m1d2t2(m1out2t,m1dout2d)
>m1duty2.out_m1d2t2.out$ldr2d
>m1trt2.out_m1d2t2.out$ldr2t
```

># Similar functions and commands used to obtain the following tables
># m1duty5.out, m1trt5.out, m1duty6.out, m1trt6.out, m1duty10.out, m1trt10.out,
># m1duty11.out, m1trt11.out, m1duty12.out, and m1trt12.out
># All these files are exported to Microsoft Excel. The filtering tool is used there
># to determine which days in which SEALs were out should be counted by

```
>#  each one of the tables.
>#  These updated files are then read back into S-Plus
>#  Resulting files are named m1d2upd, m1t2upd, m1d5upd, m1t5upd, m1d6upd, m1t6upd,
>#  m1d10upd, m1t10upd, m1d11upd, m1t11upd, m1d12upd, m1t12upd

>#  Now reading to compute the day totals for Mission 1 using function daytotalsm1
> daytotalsm1
function()
{
        m1output <- matrix(0, nrow = 436, ncol = 7)
        m1output[, 1] <- dutyntrt[, 1]        # now the first col is each of the 436 days in the file
        for(i in 1:nrow(m1output)) {
                day <- m1output[i, 1]        # first day is 951204
                tabled2 <- m1d2upd[m1d2upd[, 1] == day, ]
                tabled5 <- m1d5upd[m1d5upd[, 1] == day, ]
                tabled6 <- m1d6upd[m1d6upd[, 1] == day, ]
                tabled12 <- m1d12upd[m1d12upd[, 1] == day, ]
                tabledm1 <- rbind(tabled2, tabled5, tabled6, tabled12)
                dman.days <- sum(as.numeric(tabledm1[, 7]))
                dman.hrs <- sum(as.numeric(tabledm1[, 8]))
                tablet2 <- m1t2upd[m1t2upd[, 1] == day, ]
                tablet5 <- m1t5upd[m1t5upd[, 1] == day, ]
                tablet6 <- m1t6upd[m1t6upd[, 1] == day, ]
                tablet10 <- m1t10upd[m1t10upd[, 1] == day, ]
                tablet12 <- m1t12upd[m1t12upd[, 1] == day, ]
                tabletm1 <- rbind(tablet2, tablet5, tablet6, tablet10, tablet12)
                tman.days <- sum(as.numeric(tabletm1[, 7]))
                tman.hrs <- sum(as.numeric(tabletm1[, 8]))
                m1output[i, 2] <- dman.days
                m1output[i, 3] <- dman.hrs
                m1output[i, 4] <- tman.days
                m1output[i, 5] <- tman.hrs
                m1output[i, 6] <- as.numeric(m1output[i, 2]) + as.numeric(m1output[i, 4])
                m1output[i, 7] <- as.numeric(m1output[i, 3]) + as.numeric(m1output[i, 5])
        }
        return(list(m1output = m1output))
}
>m1daytotals_daytotalsm1()
>m1totals_m1daytotals$m1output

>#  Now plot Mission 1 man-days lost over time
>#  First, create a vector of 436 days corresponding to dates 951204 through 970211
>m1dates_seq(1,436,1)
>win.graph()
>plot(as.numeric(m1dates), as.numeric(m1totals[,6]), type = "h", xlab= "Days 1 through 436,
>continue string: (representing dates 951204 - 970211)", ylab= "Man-days Lost")
> title("Mission 1 Man-days Lost Over Time")
```

APPENDIX E. MISSION ONE FILE: MAN-DAYS LOST OVER TIME

M1totals.xls File

Date	D.Man-Days	D.Man-Hrs	T.Man-Days	T.Man-Hrs	Man-Days	Man-Hrs
951204	1	24	0	0	1	24
951205	1	24	0	0	1	24
951206	1	24	0	0	1	24
951207	1	24	0	0	1	24
951208	1	24	0	0	1	24
951209	1	24	0	0	1	24
951210	1	24	0	0	1	24
951211	1	24	0	0	1	24
951212	1	24	0	0	1	24
951213	1	24	0	0	1	24
951214	1	24	0	0	1	24
951215	1	24	0.5	12	1.5	36
951216	1	24	0.5	12	1.5	36
951217	1	24	0.5	12	1.5	36
951218	1	24	0.5	12	1.5	36
951219	1	24	0.5	12	1.5	36
951220	1	24	0.5	12	1.5	36
951221	1	24	0.5	12	1.5	36
951222	1	24	0.5	12	1.5	36
951223	1	24	0.5	12	1.5	36
951224	1	24	0.5	12	1.5	36
951225	1	24	0.5	12	1.5	36
951226	1	24	0.5	12	1.5	36
951227	1	24	0.5	12	1.5	36
951228	1	24	0.5	12	1.5	36
951229	1	24	0.5	12	1.5	36
951230	1	24	0.5	12	1.5	36
951231	1	24	0.5	12	1.5	36
960101	2	48	0.5	12	2.5	60
960102	2	48	1	24	3	72
960103	2	48	1	24	3	72
960104	2	48	1	24	3	72
960105	2	48	1	24	3	72
960106	2	48	1	24	3	72
960107	2	48	1	24	3	72
960108	2	48	1.5	36	3.5	84
960109	2	48	1.5	36	3.5	84
960110	1	24	2.5	60	3.5	84
960111	2	48	2.5	60	4.5	108
960112	3	72	2	48	5	120
960113	3	72	2	48	5	120
960114	3	72	2	48	5	120
960115	3	72	2.5	60	5.5	132
960116	4	96	2.5	60	6.5	156
960117	5	120	2	48	7	168
960118	5	120	2	48	7	168
960119	5	120	2	48	7	168
960120	5	120	2	48	7	168
960121	5	120	2	48	7	168

Date	D.Man-Days	D.Man-Hrs	T.Man-Days	T.Man-Hrs	Man-Days	Man-Hrs
960122	4	96	3	72	7	168
960123	5	120	5	120	10	240
960124	5	120	4.5	108	9.5	228
960125	6	144	4.5	108	10.5	252
960126	6	144	4.5	108	10.5	252
960127	5	120	4.5	108	9.5	228
960128	5	120	4.5	108	9.5	228
960129	5	120	4.5	108	9.5	228
960130	5	120	4.5	108	9.5	228
960131	5	120	4.5	108	9.5	228
960201	5	120	4.5	108	9.5	228
960202	5	120	5	120	10	240
960203	5	120	4.5	108	9.5	228
960204	5	120	4.5	108	9.5	228
960205	5	120	5	120	10	240
960206	5	120	5	120	10	240
960207	5	120	5	120	10	240
960208	7	168	6	144	13	312
960209	6	144	6.5	156	12.5	300
960210	6	144	5.5	132	11.5	276
960211	5	120	6	144	11	264
960212	5	120	6.5	156	11.5	276
960213	6	144	9	216	15	360
960214	6	144	8.5	204	14.5	348
960215	5	120	9	216	14	336
960216	5	120	9.5	228	14.5	348
960217	5	120	8.5	204	13.5	324
960218	5	120	8.5	204	13.5	324
960219	5	120	8.5	204	13.5	324
960220	6	144	9	216	15	360
960221	8	192	9	216	17	408
960222	8	192	10	240	18	432
960223	8	192	10	240	18	432
960224	8	192	9	216	17	408
960225	8	192	9	216	17	408
960226	8	192	9	216	17	408
960227	9	216	9	216	18	432
960228	9	216	9.5	228	18.5	444
960229	8	192	9	216	17	408
960301	8	192	9	216	17	408
960302	7	168	8.5	204	15.5	372
960303	7	168	8.5	204	15.5	372
960304	8	192	9	216	17	408
960305	8	192	9.5	228	17.5	420
960306	8	192	10	240	18	432
960307	8	192	9.5	228	17.5	420
960308	8	192	9	216	17	408
960309	8	192	9	216	17	408
960310	8	192	9	216	17	408
960311	9	216	9	216	18	432
960312	8	192	8.5	204	16.5	396
960313	8	192	9.5	228	17.5	420
960314	8	192	10	240	18	432
960315	9	216	9.5	228	18.5	444
960316	8	192	9	216	17	408

Date	D.Man-Days	D.Man-Hrs	T.Man-Days	T.Man-Hrs	Man-Days	Man-Hrs
960317	8	192	9	216	17	408
960318	10	240	9	216	19	456
960319	14	336	10.5	252	24.5	588
960320	13	312	11.5	276	24.5	588
960321	12	288	11	264	23	552
960322	13	312	10.5	252	23.5	564
960323	13	312	10	240	23	552
960324	13	312	10	240	23	552
960325	15	360	10	240	25	600
960326	14	336	10	240	24	576
960327	15	360	10.5	252	25.5	612
960328	15	360	11	264	26	624
960329	15	360	11	264	26	624
960330	13	312	12	288	25	600
960331	13	312	11.5	276	24.5	588
960401	13	312	11.5	276	24.5	588
960402	10	240	13	312	23	552
960403	12	288	12.5	300	24.5	588
960404	12	288	11	264	23	552
960405	11	264	10.5	252	21.5	516
960406	9	216	11	264	20	480
960407	9	216	11	264	20	480
960408	9	216	11	264	20	480
960409	8	192	11.5	276	19.5	468
960410	8	192	12	288	20	480
960411	9	216	12.5	300	21.5	516
960412	8	192	12.5	300	20.5	492
960413	8	192	12.5	300	20.5	492
960414	8	192	12.5	300	20.5	492
960415	8	192	13	312	21	504
960416	8	192	13	312	21	504
960417	8	192	13.5	324	21.5	516
960418	9	216	13	312	22	528
960419	7	168	13.5	324	20.5	492
960420	7	168	13	312	20	480
960421	7	168	13	312	20	480
960422	7	168	13	312	20	480
960423	9	216	12	288	21	504
960424	9	216	12.5	300	21.5	516
960425	9	216	12.5	300	21.5	516
960426	10	240	12.5	300	22.5	540
960427	10	240	12.5	300	22.5	540
960428	10	240	12.5	300	22.5	540
960429	10	240	13	312	23	552
960430	9	216	12.5	300	21.5	516
960501	9	216	12	288	21	504
960502	7	168	12.5	300	19.5	468
960503	7	168	12	288	19	456
960504	7	168	11.5	276	18.5	444
960505	7	168	11.5	276	18.5	444
960506	7	168	12.5	300	19.5	468
960507	6	144	12.5	300	18.5	444
960508	6	144	12.5	300	18.5	444
960509	6	144	13	312	19	456
960510	6	144	13	312	19	456
960511	6	144	13	312	19	456

Date	D.Man-Days	D.Man-Hrs	T.Man-Days	T.Man-Hrs	Man-Days	Man-Hrs
960512	6	144	13	312	19	456
960513	7	168	13.5	324	20.5	492
960514	8	192	13.5	324	21.5	516
960515	7	168	14	336	21	504
960516	7	168	13.5	324	20.5	492
960517	7	168	13.5	324	20.5	492
960518	7	168	13.5	324	20.5	492
960519	7	168	13.5	324	20.5	492
960520	7	168	13.5	324	20.5	492
960521	7	168	12.5	300	19.5	468
960522	7	168	12	288	19	456
960523	7	168	10.5	252	17.5	420
960524	6	144	10.5	252	16.5	396
960525	6	144	10.5	252	16.5	396
960526	6	144	10.5	252	16.5	396
960527	6	144	10.5	252	16.5	396
960528	7	168	11	264	18	432
960529	5	120	10.5	252	15.5	372
960530	5	120	10.5	252	15.5	372
960531	5	120	10.5	252	15.5	372
960601	5	120	10.5	252	15.5	372
960602	5	120	10.5	252	15.5	372
960603	5	120	10.5	252	15.5	372
960604	5	120	10	240	15	360
960605	5	120	10	240	15	360
960606	5	120	9.5	228	14.5	348
960607	5	120	9.5	228	14.5	348
960608	5	120	9.5	228	14.5	348
960609	3	72	10	240	13	312
960610	3	72	10	240	13	312
960611	3	72	9	216	12	288
960612	3	72	9	216	12	288
960613	3	72	9	216	12	288
960614	3	72	9	216	12	288
960615	3	72	9	216	12	288
960616	3	72	9	216	12	288
960617	3	72	9	216	12	288
960618	3	72	9.5	228	12.5	300
960619	5	120	9	216	14	336
960620	3	72	8.5	204	11.5	276
960621	3	72	8.5	204	11.5	276
960622	3	72	8.5	204	11.5	276
960623	3	72	8.5	204	11.5	276
960624	6	144	8.5	204	14.5	348
960625	6	144	9	216	15	360
960626	7	168	9.5	228	16.5	396
960627	6	144	9.5	228	15.5	372
960628	7	168	9	216	16	384
960629	7	168	9	216	16	384
960630	7	168	9	216	16	384
960701	7	168	9	216	16	384
960702	8	192	9	216	17	408
960703	9	216	9	216	18	432
960704	9	216	9	216	18	432
960705	6	144	9	216	15	360
960706	6	144	9	216	15	360

Date	D.Man-Days	D.Man-Hrs	T.Man-Days	T.Man-Hrs	Man-Days	Man-Hrs
960707	6	144	9	216	15	360
960708	6	144	9	216	15	360
960709	5	120	9.5	228	14.5	348
960710	3	72	10	240	13	312
960711	3	72	9.5	228	12.5	300
960712	3	72	9.5	228	12.5	300
960713	3	72	9.5	228	12.5	300
960714	2	48	9.5	228	11.5	276
960715	2	48	10	240	12	288
960716	2	48	9.5	228	11.5	276
960717	2	48	9.5	228	11.5	276
960718	2	48	9.5	228	11.5	276
960719	2	48	9.5	228	11.5	276
960720	2	48	9.5	228	11.5	276
960721	2	48	9.5	228	11.5	276
960722	3	72	9.5	228	12.5	300
960723	3	72	11	264	14	336
960724	3	72	11	264	14	336
960725	2	48	11.5	276	13.5	324
960726	2	48	11.5	276	13.5	324
960727	2	48	11	264	13	312
960728	2	48	11	264	13	312
960729	2	48	11.5	276	13.5	324
960730	1	24	12	288	13	312
960731	1	24	12	288	13	312
960801	1	24	12.5	300	13.5	324
960802	0	0	12.5	300	12.5	300
960803	0	0	13	312	13	312
960804	0	0	13	312	13	312
960805	0	0	13.5	324	13.5	324
960806	0	0	13	312	13	312
960807	0	0	13.5	324	13.5	324
960808	0	0	13.5	324	13.5	324
960809	0	0	13.5	324	13.5	324
960810	0	0	12.5	300	12.5	300
960811	0	0	12.5	300	12.5	300
960812	0	0	12.5	300	12.5	300
960813	0	0	12	288	12	288
960814	2	48	11	264	13	312
960815	2	48	10.5	252	12.5	300
960816	2	48	9.5	228	11.5	276
960817	2	48	9.5	228	11.5	276
960818	2	48	9.5	228	11.5	276
960819	2	48	9.5	228	11.5	276
960820	3	72	10.5	252	13.5	324
960821	3	72	10.5	252	13.5	324
960822	2	48	10.5	252	12.5	300
960823	2	48	10	240	12	288
960824	2	48	10	240	12	288
960825	1	24	10	240	11	264
960826	2	48	10	240	12	288
960827	3	72	10	240	13	312
960828	3	72	10	240	13	312
960829	3	72	10.5	252	13.5	324
960830	3	72	10.5	252	13.5	324
960831	3	72	10.5	252	13.5	324

Date	D.Man-Days	D.Man-Hrs	T.Man-Days	T.Man-Hrs	Man-Days	Man-Hrs
960901	3	72	11	264	14	336
960902	3	72	11.5	276	14.5	348
960903	3	72	12.5	300	15.5	372
960904	3	72	13.5	324	16.5	396
960905	3	72	15.5	372	18.5	444
960906	3	72	15	360	18	432
960907	2	48	15	360	17	408
960908	2	48	15	360	17	408
960909	2	48	15	360	17	408
960910	2	48	17	408	19	456
960911	1	24	16	384	17	408
960912	1	24	16	384	17	408
960913	1	24	16	384	17	408
960914	1	24	15.5	372	16.5	396
960915	1	24	15.5	372	16.5	396
960916	1	24	17	408	18	432
960917	1	24	16.5	396	17.5	420
960918	1	24	17	408	18	432
960919	1	24	16.5	396	17.5	420
960920	1	24	15	360	16	384
960921	1	24	15	360	16	384
960922	1	24	15	360	16	384
960923	1	24	15	360	16	384
960924	1	24	15.5	372	16.5	396
960925	1	24	14	336	15	360
960926	1	24	13.5	324	14.5	348
960927	1	24	12.5	300	13.5	324
960928	1	24	11.5	276	12.5	300
960929	1	24	11.5	276	12.5	300
960930	1	24	11.5	276	12.5	300
961001	1	24	12	288	13	312
961002	1	24	11.5	276	12.5	300
961003	1	24	11.5	276	12.5	300
961004	1	24	11	264	12	288
961005	1	24	10.5	252	11.5	276
961006	1	24	11	264	12	288
961007	1	24	11	264	12	288
961008	2	48	11	264	13	312
961009	2	48	10.5	252	12.5	300
961010	3	72	10	240	13	312
961011	3	72	10	240	13	312
961012	3	72	11	264	14	336
961013	3	72	11	264	14	336
961014	3	72	11	264	14	336
961015	3	72	11	264	14	336
961016	3	72	11	264	14	336
961017	3	72	11.5	276	14.5	348
961018	3	72	11.5	276	14.5	348
961019	2	48	12.5	300	14.5	348
961020	2	48	13.5	324	15.5	372
961021	2	48	13.5	324	15.5	372
961022	2	48	13	312	15	360
961023	3	72	13	312	16	384
961024	3	72	13	312	16	384
961025	3	72	12.5	300	15.5	372
961026	3	72	12.5	300	15.5	372

Date	D.Man-Days	D.Man-Hrs	T.Man-Days	T.Man-Hrs	Man-Days	Man-Hrs
961027	3	72	13.5	324	16.5	396
961028	3	72	13.5	324	16.5	396
961029	3	72	12.5	300	15.5	372
961030	4	96	12	288	16	384
961031	4	96	10	240	14	336
961101	3	72	9.5	228	12.5	300
961102	2	48	10	240	12	288
961103	2	48	10.5	252	12.5	300
961104	2	48	11	264	13	312
961105	2	48	10.5	252	12.5	300
961106	2	48	10	240	12	288
961107	2	48	10	240	12	288
961108	3	72	10	240	13	312
961109	3	72	10	240	13	312
961110	3	72	10	240	13	312
961111	3	72	10	240	13	312
961112	3	72	10	240	13	312
961113	3	72	10	240	13	312
961114	3	72	11	264	14	336
961115	2	48	11.5	276	13.5	324
961116	2	48	10.5	252	12.5	300
961117	2	48	10.5	252	12.5	300
961118	3	72	10	240	13	312
961119	3	72	10	240	13	312
961120	3	72	9.5	228	12.5	300
961121	2	48	9.5	228	11.5	276
961122	3	72	8	192	11	264
961123	2	48	8	192	10	240
961124	2	48	8	192	10	240
961125	3	72	8	192	11	264
961126	3	72	8.5	204	11.5	276
961127	3	72	7.5	180	10.5	252
961128	3	72	7	168	10	240
961129	3	72	7.5	180	10.5	252
961130	3	72	7.5	180	10.5	252
961201	3	72	7.5	180	10.5	252
961202	2	48	7.5	180	9.5	228
961203	2	48	7	168	9	216
961204	2	48	7	168	9	216
961205	3	72	6.5	156	9.5	228
961206	3	72	6.5	156	9.5	228
961207	3	72	6.5	156	9.5	228
961208	3	72	6.5	156	9.5	228
961209	3	72	6.5	156	9.5	228
961210	4	96	6.5	156	10.5	252
961211	4	96	6.5	156	10.5	252
961212	4	96	6.5	156	10.5	252
961213	4	96	7	168	11	264
961214	2	48	7	168	9	216
961215	2	48	8.5	204	10.5	252
961216	2	48	8.5	204	10.5	252
961217	2	48	8.5	204	10.5	252
961218	2	48	8.5	204	10.5	252
961219	2	48	8	192	10	240
961220	1	24	7	168	8	192
961221	1	24	6.5	156	7.5	180

Date	D.Man-Days	D.Man-Hrs	T.Man-Days	T.Man-Hrs	Man-Days	Man-Hrs
961222	1	24	6.5	156	7.5	180
961223	1	24	6.5	156	7.5	180
961224	1	24	5.5	132	6.5	156
961225	1	24	5.5	132	6.5	156
961226	1	24	5.5	132	6.5	156
961227	1	24	5.5	132	6.5	156
961228	1	24	5.5	132	6.5	156
961229	1	24	7	168	8	192
961230	1	24	7	168	8	192
961231	1	24	7	168	8	192
970101	1	24	7	168	8	192
970102	1	24	7	168	8	192
970103	1	24	7	168	8	192
970104	1	24	7	168	8	192
970105	1	24	7	168	8	192
970106	1	24	7	168	8	192
970107	2	48	7	168	9	216
970108	2	48	7	168	9	216
970109	2	48	7	168	9	216
970110	2	48	7.5	180	9.5	228
970111	2	48	7.5	180	9.5	228
970112	2	48	7.5	180	9.5	228
970113	2	48	7	168	9	216
970114	2	48	6.5	156	8.5	204
970115	2	48	6	144	8	192
970116	2	48	4.5	108	6.5	156
970117	2	48	4	96	6	144
970118	2	48	4.5	108	6.5	156
970119	2	48	4.5	108	6.5	156
970120	2	48	4.5	108	6.5	156
970121	2	48	4.5	108	6.5	156
970122	2	48	3.5	84	5.5	132
970123	2	48	3.5	84	5.5	132
970124	2	48	3.5	84	5.5	132
970125	2	48	3	72	5	120
970126	2	48	3	72	5	120
970127	2	48	3	72	5	120
970128	2	48	3	72	5	120
970129	2	48	3	72	5	120
970130	2	48	2.5	60	4.5	108
970131	2	48	1.5	36	3.5	84
970201	2	48	1.5	36	3.5	84
970202	2	48	1.5	36	3.5	84
970203	2	48	1.5	36	3.5	84
970204	2	48	1.5	36	3.5	84
970205	2	48	1.5	36	3.5	84
970206	2	48	0.5	12	2.5	60
970207	2	48	0.5	12	2.5	60
970208	2	48	0	0	2	48
970209	2	48	0	0	2	48
970210	2	48	0	0	2	48
970211	2	48	0	0	2	48

APPENDIX F. ACTIVITY FOUR FILE: MAN-DAYS LOST OVER TIME

A4totals.xls

Day	D.Man-Days	D.Man-Hrs	T.Man-Days	T.Man-Hrs	Man-Days	Man-Hrs
951204	0	0	0	0	0	0
951205	0	0	0	0	0	0
951206	0	0	0	0	0	0
951207	0	0	0	0	0	0
951208	0	0	0	0	0	0
951209	0	0	0	0	0	0
951210	0	0	0	0	0	0
951211	0	0	0	0	0	0
951212	0	0	0	0	0	0
951213	0	0	0	0	0	0
951214	0	0	0	0	0	0
951215	0	0	0	0	0	0
951216	0	0	0	0	0	0
951217	0	0	0	0	0	0
951218	0	0	0	0	0	0
951219	0	0	0	0	0	0
951220	0	0	0	0	0	0
951221	0	0	0	0	0	0
951222	0	0	0	0	0	0
951223	0	0	0	0	0	0
951224	0	0	0	0	0	0
951225	0	0	0	0	0	0
951226	0	0	0	0	0	0
951227	0	0	0	0	0	0
951228	0	0	0	0	0	0
951229	0	0	0	0	0	0
951230	0	0	0	0	0	0
951231	0	0	0	0	0	0
960101	0	0	0	0	0	0
960102	0	0	0	0	0	0
960103	0	0	0	0	0	0
960104	0	0	0	0	0	0
960105	0	0	0	0	0	0
960106	0	0	0	0	0	0
960107	0	0	0	0	0	0
960108	0	0	0	0	0	0
960109	0	0	0	0	0	0
960110	0	0	0	0	0	0
960111	0	0	0	0	0	0
960112	0	0	0	0	0	0
960113	0	0	0	0	0	0
960114	0	0	0	0	0	0
960115	0	0	1	24	0.5	12
960116	0	0	1	24	0.5	12
960117	0	0	1	24	0.5	12
960118	0	0	1	24	0.5	12
960119	0	0	1	24	0.5	12
960120	0	0	1	24	0.5	12
960121	0	0	1	24	0.5	12

Day	D.Man-Days	D.Man-Hrs	T.Man-Days	T.Man-Hrs	Man-Days	Man-Hrs
960122	0	0	1	24	0.5	12
960123	0	0	2	48	1	24
960124	0	0	2	48	1	24
960125	0	0	2	48	1	24
960126	0	0	2	48	1	24
960127	0	0	2	48	1	24
960128	0	0	2	48	1	24
960129	0	0	2	48	1	24
960130	0	0	2	48	1	24
960131	0	0	2	48	1	24
960201	0	0	2	48	1	24
960202	0	0	2	48	1	24
960203	0	0	2	48	1	24
960204	0	0	2	48	1	24
960205	0	0	2	48	1	24
960206	0	0	2	48	1	24
960207	0	0	3	72	1.5	36
960208	0	0	4	96	2	48
960209	0	0	4	96	2	48
960210	0	0	4	96	2	48
960211	0	0	4	96	2	48
960212	0	0	4	96	2	48
960213	0	0	6	144	3	72
960214	0	0	7	168	3.5	84
960215	0	0	6	144	3	72
960216	0	0	6	144	3	72
960217	0	0	5	120	2.5	60
960218	0	0	5	120	2.5	60
960219	0	0	5	120	2.5	60
960220	0	0	5	120	2.5	60
960221	0	0	5	120	2.5	60
960222	0	0	5	120	2.5	60
960223	0	0	5	120	2.5	60
960224	0	0	5	120	2.5	60
960225	0	0	5	120	2.5	60
960226	0	0	5	120	2.5	60
960227	0	0	5	120	2.5	60
960228	0	0	5	120	2.5	60
960229	0	0	5	120	2.5	60
960301	0	0	5	120	2.5	60
960302	0	0	5	120	2.5	60
960303	0	0	5	120	2.5	60
960304	0	0	5	120	2.5	60
960305	0	0	6	144	3	72
960306	0	0	6	144	3	72
960307	0	0	5	120	2.5	60
960308	0	0	5	120	2.5	60
960309	0	0	5	120	2.5	60
960310	0	0	5	120	2.5	60
960311	0	0	5	120	2.5	60
960312	0	0	5	120	2.5	60
960313	0	0	5	120	2.5	60
960314	0	0	5	120	2.5	60
960315	0	0	5	120	2.5	60
960316	0	0	5	120	2.5	60
960317	0	0	5	120	2.5	60

Day	D.Man-Days	D.Man-Hrs	T.Man-Days	T.Man-Hrs	Man-Days	Man-Hrs
960318	0	0	5	120	2.5	60
960319	1	24	7	168	4.5	108
960320	1	24	8	192	5	120
960321	1	24	6	144	4	96
960322	1	24	6	144	4	96
960323	1	24	5	120	3.5	84
960324	1	24	5	120	3.5	84
960325	1	24	5	120	3.5	84
960326	1	24	5	120	3.5	84
960327	1	24	6	144	4	96
960328	1	24	6	144	4	96
960329	1	24	6	144	4	96
960330	1	24	6	144	4	96
960331	1	24	6	144	4	96
960401	1	24	6	144	4	96
960402	1	24	6	144	4	96
960403	1	24	6	144	4	96
960404	1	24	5	120	3.5	84
960405	1	24	5	120	3.5	84
960406	1	24	5	120	3.5	84
960407	1	24	5	120	3.5	84
960408	1	24	5	120	3.5	84
960409	1	24	6	144	4	96
960410	1	24	6	144	4	96
960411	1	24	6	144	4	96
960412	1	24	6	144	4	96
960413	1	24	6	144	4	96
960414	1	24	6	144	4	96
960415	1	24	6	144	4	96
960416	1	24	6	144	4	96
960417	2	48	6	144	5	120
960418	2	48	6	144	5	120
960419	2	48	6	144	5	120
960420	2	48	6	144	5	120
960421	2	48	6	144	5	120
960422	2	48	6	144	5	120
960423	3	72	6	144	6	144
960424	3	72	6	144	6	144
960425	3	72	6	144	6	144
960426	3	72	6	144	6	144
960427	3	72	6	144	6	144
960428	3	72	6	144	6	144
960429	3	72	7	168	6.5	156
960430	3	72	6	144	6	144
960501	3	72	6	144	6	144
960502	2	48	7	168	5.5	132
960503	2	48	7	168	5.5	132
960504	2	48	7	168	5.5	132
960505	2	48	7	168	5.5	132
960506	2	48	7	168	5.5	132
960507	1	24	8	192	5	120
960508	1	24	8	192	5	120
960509	1	24	8	192	5	120
960510	1	24	8	192	5	120
960511	1	24	8	192	5	120
960512	1	24	8	192	5	120

Day	D.Man-Days	D.Man-Hrs	T.Man-Days	T.Man-Hrs	Man-Days	Man-Hrs
960513	1	24	8	192	5	120
960514	1	24	8	192	5	120
960515	1	24	8	192	5	120
960516	1	24	8	192	5	120
960517	1	24	8	192	5	120
960518	1	24	8	192	5	120
960519	1	24	8	192	5	120
960520	1	24	8	192	5	120
960521	1	24	7	168	4.5	108
960522	1	24	7	168	4.5	108
960523	1	24	7	168	4.5	108
960524	1	24	7	168	4.5	108
960525	1	24	7	168	4.5	108
960526	1	24	7	168	4.5	108
960527	1	24	7	168	4.5	108
960528	1	24	7	168	4.5	108
960529	1	24	6	144	4	96
960530	1	24	6	144	4	96
960531	1	24	6	144	4	96
960601	1	24	6	144	4	96
960602	1	24	6	144	4	96
960603	1	24	6	144	4	96
960604	1	24	6	144	4	96
960605	1	24	6	144	4	96
960606	1	24	6	144	4	96
960607	1	24	6	144	4	96
960608	1	24	6	144	4	96
960609	1	24	6	144	4	96
960610	1	24	6	144	4	96
960611	1	24	5	120	3.5	84
960612	1	24	5	120	3.5	84
960613	1	24	5	120	3.5	84
960614	1	24	5	120	3.5	84
960615	1	24	5	120	3.5	84
960616	1	24	5	120	3.5	84
960617	1	24	5	120	3.5	84
960618	1	24	5	120	3.5	84
960619	1	24	4	96	3	72
960620	0	0	5	120	2.5	60
960621	0	0	5	120	2.5	60
960622	0	0	5	120	2.5	60
960623	0	0	5	120	2.5	60
960624	0	0	5	120	2.5	60
960625	0	0	6	144	3	72
960626	1	24	7	168	4.5	108
960627	1	24	7	168	4.5	108
960628	1	24	7	168	4.5	108
960629	1	24	7	168	4.5	108
960630	1	24	7	168	4.5	108
960701	1	24	7	168	4.5	108
960702	2	48	7	168	5.5	132
960703	2	48	7	168	5.5	132
960704	2	48	7	168	5.5	132
960705	2	48	7	168	5.5	132
960706	2	48	7	168	5.5	132

Day	D.Man-Days	D.Man-Hrs	T.Man-Days	T.Man-Hrs	Man-Days	Man-Hrs
960707	2	48	7	168	5.5	132
960708	2	48	7	168	5.5	132
960709	2	48	7	168	5.5	132
960710	2	48	7	168	5.5	132
960711	2	48	7	168	5.5	132
960712	2	48	7	168	5.5	132
960713	2	48	7	168	5.5	132
960714	1	24	7	168	4.5	108
960715	1	24	7	168	4.5	108
960716	1	24	7	168	4.5	108
960717	0	0	7	168	3.5	84
960718	0	0	7	168	3.5	84
960719	0	0	7	168	3.5	84
960720	0	0	7	168	3.5	84
960721	0	0	7	168	3.5	84
960722	0	0	7	168	3.5	84
960723	0	0	8	192	4	96
960724	0	0	9	216	4.5	108
960725	0	0	9	216	4.5	108
960726	0	0	9	216	4.5	108
960727	0	0	9	216	4.5	108
960728	0	0	9	216	4.5	108
960729	0	0	9	216	4.5	108
960730	0	0	9	216	4.5	108
960731	0	0	8	192	4	96
960801	0	0	8	192	4	96
960802	0	0	8	192	4	96
960803	0	0	8	192	4	96
960804	0	0	8	192	4	96
960805	0	0	8	192	4	96
960806	0	0	8	192	4	96
960807	0	0	8	192	4	96
960808	0	0	8	192	4	96
960809	0	0	8	192	4	96
960810	0	0	7	168	3.5	84
960811	0	0	7	168	3.5	84
960812	0	0	7	168	3.5	84
960813	0	0	7	168	3.5	84
960814	0	0	7	168	3.5	84
960815	0	0	7	168	3.5	84
960816	0	0	7	168	3.5	84
960817	0	0	7	168	3.5	84
960818	0	0	7	168	3.5	84
960819	0	0	7	168	3.5	84
960820	1	24	7	168	4.5	108
960821	1	24	7	168	4.5	108
960822	1	24	7	168	4.5	108
960823	1	24	7	168	4.5	108
960824	1	24	7	168	4.5	108
960825	1	24	7	168	4.5	108
960826	1	24	7	168	4.5	108
960827	2	48	7	168	5.5	132
960828	2	48	7	168	5.5	132
960829	2	48	7	168	5.5	132
960830	2	48	7	168	5.5	132
960831	2	48	7	168	5.5	132

Day	D.Man-Days	D.Man-Hrs	T.Man-Days	T.Man-Hrs	Man-Days	Man-Hrs
960901	2	48	8	192	6	144
960902	2	48	8	192	6	144
960903	2	48	9	216	6.5	156
960904	2	48	9	216	6.5	156
960905	2	48	10	240	7	168
960906	2	48	9	216	6.5	156
960907	1	24	9	216	5.5	132
960908	1	24	9	216	5.5	132
960909	1	24	9	216	5.5	132
960910	1	24	10	240	6	144
960911	1	24	9	216	5.5	132
960912	1	24	9	216	5.5	132
960913	1	24	9	216	5.5	132
960914	1	24	9	216	5.5	132
960915	1	24	9	216	5.5	132
960916	1	24	9	216	5.5	132
960917	1	24	9	216	5.5	132
960918	1	24	9	216	5.5	132
960919	1	24	9	216	5.5	132
960920	1	24	8	192	5	120
960921	1	24	8	192	5	120
960922	1	24	8	192	5	120
960923	1	24	8	192	5	120
960924	1	24	9	216	5.5	132
960925	1	24	9	216	5.5	132
960926	1	24	8	192	5	120
960927	1	24	7	168	4.5	108
960928	1	24	6	144	4	96
960929	1	24	6	144	4	96
960930	1	24	6	144	4	96
961001	1	24	6	144	4	96
961002	1	24	6	144	4	96
961003	1	24	6	144	4	96
961004	1	24	5	120	3.5	84
961005	1	24	5	120	3.5	84
961006	1	24	5	120	3.5	84
961007	1	24	5	120	3.5	84
961008	1	24	5	120	3.5	84
961009	1	24	5	120	3.5	84
961010	1	24	5	120	3.5	84
961011	1	24	5	120	3.5	84
961012	1	24	6	144	4	96
961013	1	24	6	144	4	96
961014	1	24	6	144	4	96
961015	1	24	6	144	4	96
961016	1	24	6	144	4	96
961017	1	24	6	144	4	96
961018	1	24	6	144	4	96
961019	1	24	7	168	4.5	108
961020	1	24	7	168	4.5	108
961021	1	24	7	168	4.5	108
961022	1	24	6	144	4	96
961023	1	24	6	144	4	96
961024	1	24	6	144	4	96
961025	1	24	7	168	4.5	108
961026	1	24	7	168	4.5	108
961027	1	24	7	168	4.5	108

Day	D.Man-Days	D.Man-Hrs	T.Man-Days	T.Man-Hrs	Man-Days	Man-Hrs
961028	1	24	7	168	4.5	108
961029	1	24	6	144	4	96
961030	1	24	6	144	4	96
961031	1	24	6	144	4	96
961101	1	24	6	144	4	96
961102	1	24	7	168	4.5	108
961103	1	24	7	168	4.5	108
961104	1	24	7	168	4.5	108
961105	1	24	6	144	4	96
961106	1	24	5	120	3.5	84
961107	1	24	5	120	3.5	84
961108	2	48	4	96	4	96
961109	2	48	4	96	4	96
961110	2	48	4	96	4	96
961111	2	48	4	96	4	96
961112	2	48	4	96	4	96
961113	2	48	4	96	4	96
961114	2	48	4	96	4	96
961115	2	48	4	96	4	96
961116	2	48	4	96	4	96
961117	2	48	4	96	4	96
961118	2	48	4	96	4	96
961119	2	48	4	96	4	96
961120	2	48	4	96	4	96
961121	1	24	4	96	3	72
961122	1	24	4	96	3	72
961123	0	0	4	96	2	48
961124	0	0	4	96	2	48
961125	0	0	4	96	2	48
961126	0	0	4	96	2	48
961127	0	0	4	96	2	48
961128	0	0	4	96	2	48
961129	0	0	5	120	2.5	60
961130	0	0	5	120	2.5	60
961201	0	0	5	120	2.5	60
961202	0	0	5	120	2.5	60
961203	0	0	5	120	2.5	60
961204	0	0	5	120	2.5	60
961205	0	0	5	120	2.5	60
961206	0	0	5	120	2.5	60
961207	0	0	5	120	2.5	60
961208	0	0	5	120	2.5	60
961209	0	0	5	120	2.5	60
961210	0	0	5	120	2.5	60
961211	0	0	5	120	2.5	60
961212	0	0	5	120	2.5	60
961213	0	0	5	120	2.5	60
961214	0	0	5	120	2.5	60
961215	0	0	5	120	2.5	60
961216	0	0	5	120	2.5	60
961217	0	0	5	120	2.5	60
961218	0	0	5	120	2.5	60
961219	0	0	5	120	2.5	60
961220	0	0	4	96	2	48
961221	0	0	4	96	2	48
961222	0	0	4	96	2	48

Day	D.Man-Days	D.Man-Hrs	T.Man-Days	T.Man-Hrs	Man-Days	Man-Hrs
961223	0	0	4	96	2	48
961224	0	0	3	72	1.5	36
961225	0	0	3	72	1.5	36
961226	0	0	3	72	1.5	36
961227	0	0	3	72	1.5	36
961228	0	0	3	72	1.5	36
961229	0	0	3	72	1.5	36
961230	0	0	3	72	1.5	36
961231	0	0	3	72	1.5	36
970101	0	0	3	72	1.5	36
970102	0	0	3	72	1.5	36
970103	0	0	3	72	1.5	36
970104	0	0	3	72	1.5	36
970105	0	0	3	72	1.5	36
970106	0	0	3	72	1.5	36
970107	0	0	2	48	1	24
970108	0	0	2	48	1	24
970109	0	0	2	48	1	24
970110	0	0	2	48	1	24
970111	0	0	2	48	1	24
970112	0	0	2	48	1	24
970113	0	0	2	48	1	24
970114	0	0	2	48	1	24
970115	0	0	1	24	0.5	12
970116	0	0	1	24	0.5	12
970117	0	0	1	24	0.5	12
970118	0	0	2	48	1	24
970119	0	0	2	48	1	24
970120	0	0	2	48	1	24
970121	0	0	2	48	1	24
970122	0	0	2	48	1	24
970123	0	0	2	48	1	24
970124	0	0	2	48	1	24
970125	0	0	2	48	1	24
970126	0	0	2	48	1	24
970127	0	0	2	48	1	24
970128	0	0	2	48	1	24
970129	0	0	2	48	1	24
970130	0	0	2	48	1	24
970131	0	0	2	48	1	24
970201	0	0	2	48	1	24
970202	0	0	2	48	1	24
970203	0	0	2	48	1	24
970204	0	0	2	48	1	24
970205	0	0	2	48	1	24
970206	0	0	1	24	0.5	12
970207	0	0	1	24	0.5	12
970208	0	0	0	0	0	0
970209	0	0	0	0	0	0
970210	0	0	0	0	0	0
970211	0	0	0	0	0	0

LIST OF REFERENCES

1. ACQWeb, Office of the Under Secretary of Defense for Acquisition and Technology, http://www.acq.osd.mil/cqi-bin/AT-ACQWeb_Mainsearch.cgi, 1997.

2. Goforth, H. W., "Exercise-related Injuries of Special Operations Personnel", pp.4, 10, Naval Health Research Center, San Diego, CA, 1993.

3. Navy Public Affairs Library, http://www.chinfo.navy.mil/navpalib/factfile/personnel/seals/seals.htm1, 1997.

4. Http://nelle.mc.duke.edu/Standards/termcode/icd9/1tabular.html, 1997.

5. Dox, Melloni, Eisner, *The Harper Collins Illustrated Medical Dictionary*, 1993.

6. Prusaczyk, Stuster, Goforth, Sopchick, Meyer, "Physical Demands of U. S. Navy Sea-Air-Land (SEAL) Operations", Naval Health Research Center Technical Report # 95-24, 1995.

INITIAL DISTRIBUTION LIST

Number of Copies

1. Defense Technical Information Center 2
   8725 John J. Kingman Rd., STE 0944
   Ft. Belvoir, VA 22060-6218

2. Dudley Knox Library 2
   Naval Postgraduate School
   411 Dyer Rd.
   Monterey, CA 93943-5101

3. Samuel Parry, Code OR/Py 2
   Department of Operations Research
   Naval Postgraduate School
   Monterey, CA 93943-5101

4. Robert Read, Code OR/Re 2
   Department of Operations Research
   Naval Postgraduate School
   Monterey, CA 93943-5101

5. Keith Prusaczyk, Code 21 2
   Naval Health Research Center
   P. O. Box 85122
   San Diego, CA 92186-5122

6. LT Erin G. Snow 2
   39344 Ruby Lane
   Pearl River, LA 70452